WEST Search History

DATE: Wednesday, March 06, 2002

Set Name side by side	Query	Hit Count	Set Name result set
	DB=USPT; PLUR=YES; OP=ADJ		
L10	map and L9	47	L10
L9	globe and L8	53	L9
L8	mov$5 and L7	579	L8
L7	print$3 and L6	639	L7
L6	(coordinate$1) and L5	1442	L6
L5	(computer or processor or microprocessor or micro$1processor) and L4	2515	L5
L4	(position or location) and L3	2875	L4
L3	geographic$2 and L2	2938	L3
L2	(globe or map) and L1	41780	L2
L1	sens$3 or stylus	667144	L1

END OF SEARCH HISTORY

Set Name side by side	Query	Hit Count	Set Name result set
	DB=USPT; PLUR=YES; OP=ADJ		
L10	map and L9	47	L10
L9	globe and L8	53	L9
L8	mov$5 and L7	579	L8
L7	print$3 and L6	639	L7
L6	(coordinate$1) and L5	1442	L6
L5	(computer or processor or microprocessor or micro$1processor) and L4	2515	L5
L4	(position or location) and L3	2875	L4
L3	geographic$2 and L2	2938	L3
L2	(globe or map) and L1	41780	L2
L1	sens$3 or stylus	667144	L1

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L10: Entry 7 of 47   File: USPT   Aug 31, 1999

US-PAT-NO: 5945985
DOCUMENT-IDENTIFIER: US 5945985 A

TITLE: Information system for interactive access to geographic information

DATE-ISSUED: August 31, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Babin; Shane P.	Gretna	LA		
Barnett; Kenneth C.	Alabaster	AL		
Husseiny; Abdo A.	LaPlace	LA		

US-CL-CURRENT: 707/500.1

CLAIMS:

What is claimed:

1. An information system for interactive access to geographic information using
visual and interactive multimedia representation to retrieve global data,
comprising:

memory means for storing multimedia geographic information and a plurality of
identifying attributes;

input means for interfacing with users for receiving operating instructions
specifying queries concerning specified geographic features, multimedia geographic
information and identifying data, said input means connected with said memory means
for storing data inputted by a user;

output means for presenting multimedia geographic information and specified
geographic features stored in said memory means to said users simultaneously in
three-dimensional and two-dimensional formats using a virtual display means for
displaying geographical information on a monitor and a physical display means for
displaying a geographic world map, said virtual display means and said physical
display means operatively synchronized to output said multimedia geographic
information in unison; and

processing means including an interactive interface means connected to said memory
means, said input means, and said output means for receiving input signals from said
input means, invoking specified protocols, and generating control signals to
operatively control said information system to respond to signals received from said
input means, accessing said memory means to retrieve information requested by a user
through said input means, and determining the mode of presenting said information
requested by a user to said user via said output means, said interactive interface
means comprises graphical interface means for annunciating operating commands,
identifying keywords and animating tools and invoking associated operating protocol,
said graphical interface means comprising operating command buttons for specifying
predetermined geographic features, identifying keyword lists for listing identifying
keywords identifying corresponding said multimedia geographic information and said

specified geographic features, and animation toolbox for selecting manipulation options to manipulate and animate multimedia geographic maps and said physical display means.

2. The system of claim 1 further comprising a communication means for communicating with a remote processing means and accessing remote memory means located at remote locations, said communications means connected to said memory means for accessing and storing information sent and received by said communications means.

3. The system of claim 1 wherein said output means includes a voice output means for narrating said multimedia geographic information and vocally describing said specified geographic features.

4. The system of claim 1 wherein said processing means includes a retrieval means for retrieving said multimedia geographic information and said identifying attributes from said memory means.

5. The system of claim 1 wherein said output means further comprises production means for documenting said multimedia geographic information.

6. The system of claim 1 wherein said operating command buttons are associated with categories of said predetermined geographic features, said categories represent different levels of details of geographic regions and subregions within political boundaries on said multimedia geographic maps, activating said operating command button invokes an associated operating protocol for displaying of corresponding category of said predetermined geographic feature, prompting the display of an associated said identifying keyword list for specifying said predetermined geographic feature for displaying and highlighting said specified geographic features on said multimedia geographic maps and highlighting said specified geographic features on said physical display means.

7. The system of claim 1 wherein said animation toolbox includes a plurality of manipulation options for manipulating and animating said ·virtual display means, said animation control means comprising:

animated rotation toolbox for rotating said virtual world globe and said multimedia regional maps about the longitudinal coordinate axis and the latitudinal coordinate axis and rotating said physical display means about the longitudinal coordinate axis to expose hidden specified geographic features for direct viewing;

animated panning toolbox for moving said virtual world globe or said multimedia regional maps up and down on said virtual display means; and

animated zooming toolbox for zooming in to enlarge and reveal more details of said specified geographic features and suppress background geographic features, zooming out to change scale of said specified geographic features.

8. The system of claim 1 wherein said physical display means includes a physical world globe comprising a translucent spherical hollow shell, with the exterior of said shell displaying a rendering of a detailed said geographic world map and the interior of said shell being illuminated by a plurality of rotating light means rotating about the latitudinal axis, said rotating light means comprises dispersed light means for shining light on the interior light means comprises dispersed light means for shining light on the interior of said shell for illuminating the whole exterior of said shell and focussed light means for highlighting said specified geographic features, said focussed light means comprising:

directional illuminating means for generating concentrated light beams;

light enclosure means for enclosing said directional illumination means, reflecting said concentrated light beams in the forward direction, said light enclosure means having an interior surface and exterior surface, wherein said interior surface covered with a reflective mirror lining for reflecting said concentrated light beams, and said exterior surface is opaque, and said enclosure means having an opening facing the said directional illuminating means for passing the said

concentrated light beams out of the said light enclosure means;

light collimating means for collimating the said concentrated light beams leaving the said light enclosure means, said light collimating means is connected with said highlighting control means for controlling and adjusting the width of the collimated directed concentrated light beams; and

light focussing means for focusing the collimated light beams for highlighting said specified geographic features on said world globe, said light focussing means is rigidly attached to said light enclosure means.

9. The system of claim 6 wherein highlighting of said specified geographic features on said multimedia geographic maps distinguishes between said specified features and said background geographic features on said for contrasting said specified features from light shades of said background geographic features.

10. The system of claim 9 wherein highlighting is in different colors combining red, green and blue for distinguishing said specified features from said background geographic features on said multimedia geographic maps.

11. The system of claim 1 wherein said interactive interface means further comprises a text interface means that receives input from an alphanumeric input means for entering said geographic data associated with said predetermined geographic features and said multimedia geographic maps and queries about said specified geographic features, said multimedia geographic information and said identifiers.

12. The system of claim 1 wherein said graphical interface means receives signals from said input means, said input means comprises pointing input means for activating said specified operating protocols.

13. The system of claim 1 wherein said input means is voice input means for activating said graphical interface means following voice input recognition by said processing means.

14. The system of claim 1 wherein said graphical interface means interfacing directly with said users and receives input as a touch to a touchscreen on said computer monitor screen.

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Search Results -

Term	Documents
MAP.USPT.	68741
MAPS.USPT.	30151
(9 AND MAP).USPT.	47
(MAP AND L9).USPT.	47

Database:

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US Patents Full-Text Database
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Derwent World Patents Index
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Search: L10

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Search Results -

Term	Documents
CODED.USPT.	79231
CODEDS	0
ENCODED.USPT.	83838
ENCODEDS	0
(2 AND (CODED OR ENCODED)).USPT.	2
(L2 AND (CODED OR ENCODED)).USPT.	2

Database:

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US Patents Full-Text Database
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Search History

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Set Name	Query	Hit Count	Set Name
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DB=USPT; PLUR=YES; OP=ADJ

Set Name	Query	Hit Count	Set Name
L34	l2 and (coded or encoded)	2	L34
L33	l2 and print$3	2	L33
L32	L31 and (country or city or state or region or feature)	2	L32
L31	l2 and geographic$2	2	L31
L30	l2 and ((geographic$2) same (region or city or country or state))	0	L30
L29	l2 and mov$5	2	L29
L28	geographic$2 and L27	2	L28
L27	(coded or encoded) and L26	2	L27
L26	stylus and L25	2	L26
L25	l2 and map	2	L25
L24	l1 and map	1	L24
L23	(map near2 control$4) and L22	0	L23
L22	feature and L21	2	L22
L21	mov$5 and L20	2	L21
L20	locat$3 and l18	2	L20
L19	print$3 and l2	2	L19
L18	print$3 and L17	2	L18
L17	identif$8 and l16	2	L17
L16	l15 and (cod$3 or encod$3)	2	L16
L15	l14 and stylus	2	L15
L14	geographic$2 and l13	2	L14
L13	position and L12	2	L13
L12	receiv$3 and L11	2	L12
L11	l5 and (computer or processor)	2	L11
L10	L9 and globe	3	L10
L9	Flowers same Mark	138	L9
L8	Explore Acquisition	0	L8
L7	Explore Acquisition Corp.	0	L7
L6	5417575.pn.	1	L6
L5	L4 and map	2	L5
L4	L3 and globe	2	L4
L3	L2 and sensor	2	L3
L2	(5686705 or 5877458).pn.	2	L2
L1	5686705.pn.	1	L1

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L22: Entry 2 of 2   File: USPT   ·   Nov 11, 1997

DOCUMENT-IDENTIFIER: US 5686705 A
TITLE: Surface position location system and method

Abstract Paragraph Left (1):
Electrographic sensor and method for position determination of a selected position
thereon. Sensor includes a conductive material layer having electrical resistivity
and a surface, at least three spaced apart contact points electrically
interconnected with the layer, a processor connected to the contacts disposed to
selectively apply a signal to each contact, and a probe assembly that includes
either a stylus coupled to the processor with the stylus disposed to be positioned
by a user in vicinity of the selected position on the layer, or a flexible layer
with a user's finger selecting that position on the flexible layer to receive
signals from the layer when the contact points have signals selectively applied. The
selected position is determined by the processor from signals received from the
stylus, or flexible layer, each in relation to a similar excitation of different
pairs of the contacts. The conductive layer of either two or three dimensions
including a closed three dimensional shape. With multiple layers the processor is
able to discern on which layer the user selected position is located. Correction of
the calculated coordinates of the selected position for variations in contact
resistance of the contact points. A non-conductive skin having graphics printed
thereon, i.e. a map, can be placed over the layer and the processor further converts
the calculated coordinates of the selected position to coordinates relative to the
graphical information printed on the skin, and electronically (audio or visual)
present information to the user relative to the graphical location selected.

Brief Summary Paragraph Right (1):
The present invention relates to a system and method for determining a location
selected by a user on a surface and providing information to the user that has been
determined to be relative to that location. In particular the present invention
relates to position detection devices that are able to detect positions on a surface
of two and three dimensional objects that have complex shapes. Additionally it
relates to position detection devices in which the object may be turned, rotated or
otherwise manipulated relative to the rest of the position detection system.

Brief Summary Paragraph Right (2):
A variety of technologies exist to determine the position of a stylus, or even a
finger, placed on a surface. One technology is a grid of horizontal and vertical
wires that are placed below the surface of a flat tablet or over the surface of a
display device and emit position indicating signals which are detected by a stylus.
Two devices using this type of technology are described in U.S. Pat. Nos. 5,149,919
and 4,686,332 to Greenias, et al. Applications using these devices are computer
input drawing (or digitizing) tablets, and touch-screen display devices.

Brief Summary Paragraph Right (3):
In another technology, surface acoustic waves are measured at the edges of a glass
plate and are used to calculate the position on the plate that was selected by a
finger or a stylus. Applications include high use touch screen kiosk displays where
a conductive overlay technology would wear out.

Brief Summary Paragraph Right (4):

Yet other technologies include the use of light pens as optical detectors. Additionally a frame around a flat display with an array of light emitters and detectors around the edge of the frame, may be used to detect when a finger or stylus is near the display surface. These technologies are limited to displays or flat surfaces.

Brief Summary Paragraph Right (5):
Position detectors such as the devices disclosed in the Greanias patents, that use many conductors arranged in a grid, are not well suited to a complex shaped surface of either two or three dimensions. There are, at a minimum, difficulties in positioning and shaping the conductors to fit the contours of a complex shape.

Brief Summary Paragraph Right (6):
Another similar device is a grid of horizontal and vertical wires placed over or beneath the surface of a flat display device that uses capacitive coupling of a stylus or finger. In this device, the capacitive coupling transfers position indicating signals from one wire to another which can be used to calculate the position of the coupling. Computer input tablets, as well as finger pointing mouse replacement tablets, use this technology.

Brief Summary Paragraph Right (7):
In another technology, a rectangular homogenous transparent conductor is placed over the surface of a display device and bar contacts on the edges of the transparent conductor charge the conductor. Capacitive coupling of a stylus or a finger to the transparent conductor causes the conductor to discharge while sensors attached to the bar contacts measure the amount of current drawn through each of the contacts. Analysis of the ratios of the currents drawn from pairs of contacts on opposing sides of the rectangle provide an X-Y position on the panel that was selected by the user. A device of this type is described in U.S. Pat. No. 4,853,498 to Meadows, et al. An application of this device is a touch-screen display.

Brief Summary Paragraph Right (8):
A similar technology uses a rectangular piece of extremely uniform resistive material with a series of discrete resistors along the edge and is mounted on a flat surface. A voltage differential is applied to the row of resistors on opposing sides of the rectangle and in a time-division manner the voltage differential is applied to the row of resistors of the other two opposing sides. The position indicating signals are either received by a stylus, or by a conductive overlay which can be depressed to contact the surface of the resistive material. One variety of this device is described in U.S. Pat. No. 3,798,370 to Hurst.

Brief Summary Paragraph Right (9):
The devices described in U.S. Pat. Nos. 4,853,498 (Meadows, et al.) and 3,798,370 (Hurst) drive a homogenous rectangular resistive overlay with bar contacts or a string of resistors along each edge. These approaches rely upon the regular shape of a rectangle in order to work. The shape and placement of the contacts provide the means to detect portions of the surface within a rectangular subsection of the resistive material of the surface. Other simple shapes may also be feasible with bar and resistor string contacts but in complex shapes they can create areas that cannot be distinguished (e.g., shapes with concave edges such as a circle or ellipse can not be accommodated by either the Meadows or the Hurst approaches). The use of bar contacts or strings of resistors along substantially the entire edge of an object limits their usefulness on objects where the position on the entire surface needs to be detected. The locations directly beneath each bar electrode and between each bar or spot electrode and the edge of the object are not detectable in these devices.

Brief Summary Paragraph Right (11):
Further, Meadows loads the surface with a capacitively coupled stylus and determines position by measuring the current drawn from the driving circuits. The Meadows device requires four receiver circuits to accomplish this.

Brief Summary Paragraph Right (12):
The Meadows device is susceptible to the effects of unwanted phantom styluses coupling to the surface. Phantom styluses such as rings or fingers may couple to the active surface instead of, or in addition to, the actual stylus. These phantom

styluses cause detection errors because the changes that they also produce cause changes in the driving circuit.

Brief Summary Paragraph Right (13):
In applications where the object containing the grid needs to be rotated, or the electronics and the object are physically spaced-apart from each other, a large number of conductors must be coupled to the system, or between the elements of the systems, through connection mechanisms that may allow rotation or other movements. Such cables for the systems of the prior art would be rather large and cumbersome. Further, connectors with a large number of contacts are expensive and reduce the overall reliability of any system that requires them. Contacts that allow rotation, such as slip rings or commutators, become prohibitively complex and expensive as the number of connections rises above a small number. Additionally, the multiple circuits required to drive grid arrays are complex and costly to manufacture. Acoustic wave detectors provide a rugged position detection mechanism but are costly to implement. Light wave detection mechanisms are limited to flat surfaces and are susceptible to dust and insects blocking the light paths. It is believed, however, that the present invention solves these problems.

Brief Summary Paragraph Right (14):
The present invention includes various apparatus and methods for determining a user selected position on an electrographic sensor unit. In the most general terms the electrographic sensor unit of the present invention includes a layer of a conductive material having an electrical resistivity with K spaced apart contact points electrically interconnected with therewith, a processor connected to the K spaced apart contacts and disposed to selectively apply a signal to N of the K contact points where N has an integer value of 3 to K, and a probe assembly, including a stylus or a flexible conductive layer placed over the layer, coupled to the processor, the stylus disposed to be positioned by a user in vicinity of the user selected position on the layer, or the user to point a finger at the flexible conductive layer. In turn, the stylus, or the flexible conductive layer receives signals from the layer when the contact points have signals selectively applied thereto by the processor with the user selected position being determinable by the processor from the signals received from the stylus, or flexible layer, each in relation to a similar excitation of (N-J) different pairs of the K contact points under control of the processor, where J is an integer of 2 to (N-1).

Brief Summary Paragraph Right (15):
Additionally, where the electrographic sensor includes more than one conductive layers that are each electrically isolated from each other, in the most general sense M conductive layers, the present invention is also able to discern which of those layers contains the user selected position. Here, each layer has K spaced apart contact points electrically interconnected with the corresponding layer of conductive material where N of the K contact points on each layer are used to locate the user selected position and where N has an integer value of three to K. The processor is similarly disposed to selectively apply a signal to each of the N contact points of each of the M layers and to determine which of the M layers and position coordinates of the user selected position on the corresponding one of the M layers in cooperation with a means for detecting and delivering a signal from the user selected position on the selected layer of the electrographic sensor unit to the processor.

Brief Summary Paragraph Right (16):
The identification of the selected layer is accomplished by sequentially applying a first selected signal to all of the K contact points on each of the M layers in turn and measuring a first measured signal at said user selected position for each of the M layers individually with the first measurement corresponding to each one of the M layers being the signal received by the means for detecting and delivering when all of the contact points on that layer has the first selected signal applied to that layer's contact points.

Brief Summary Paragraph Right (17):
Next, a second measured signal is measured at the user selected position on the user selected layer for each of the M layers with each of the K contact points on each of the M layers open circuited, followed by the subtraction of the second measured

signal from the first measured signal for each of the M layers to form M difference values.

Brief Summary Paragraph Right (18):
Those M difference values are then each compared against a preselected threshold value to determine which one of those M difference values is both greater than that selected threshold and which exceeds it by the greatest value. The layer associated with the difference value that satisfies those conditions is then identified as the layer that contains the user selected position. Then once that determination is made the coordinates of the user selected position on that layer can be determined as discussed above.

Brief Summary Paragraph Right (19):
The present invention also includes techniques for compensating for contact resistance in each of the contact points on the conductive layer, as well as forming the conductive layer into a two or three dimensional shape which may be open or closed. Further, the present invention includes the placement of a conductive skin over the outer surface of layer with that skin having a graphical representation thereon and the present invention having the capability to convert the position coordinates of the user selected position from the coordinates of the conductive layer to those of the graphical representation. Such a graphical representation may be that of a map or a globe, even a mythical map or one of a star or another planet. Carrying this one step further, those graphical coordinates may also be used to electronically deliver information that has been prestored in memory relative to the selected graphical coordinates to the user.

Brief Summary Paragraph Right (20):
In actual application the present invention can take many forms from a conductive layer with or without a non-conductive layer thereon and a stylus for use by the user to select a position on the layer, to a multi-layer structure with a conductive bottom layer, a non-conductive compressible inner layer, and a flexible conductive top layer where the user presses the top layer toward the bottom layer and the point at which the top and bottom layers are closest together is determined to be the user selected position. Further, various designs are proposed wherein the actuation and measured signals are either AC of a selected frequency or DC .

Drawing Description Paragraph Right (3):
FIG. 2 is an illustration of the position location algorithm of the present invention for a two dimensional surface shape.

Drawing Description Paragraph Right (9):
FIG. 8 illustrates the restrictions on the placement of contact points to be able to determine position with only three contacts.

Drawing Description Paragraph Right (10):
FIG. 9 illustrates three contact points that can not be used to determine position on the surface.

Drawing Description Paragraph Right (11):
FIG. 10 is a partial embodiment wherein a multi-layer compressible touch surface is disclosed in lieu of the use of a stylus as, for example, in FIG. 4.

Drawing Description Paragraph Right (12):
FIG. 11 is a schematic representation of an embodiment of the present invention adapted to be an interactive globe that incorporates a spherical conductive surface.

Drawing Description Paragraph Right (13):
FIG. 12 is a schematic representation of an embodiment of the present invention adapted to be an interactive globe that incorporates two hemispherical conductive surfaces.

Detailed Description Paragraph Right (1):
The present invention relates to a system and method for determining a location on a two or three dimensional surface of any shape selected by a user, as well as

providing access to data storage locations or information stored therein that is relative to that location. More specifically, the present invention determines the location information in the form of coordinates on a predefined coordinate system. That location information then serves as an address to locations within the memory of an associated microprocessor subsystem. That location, or address may in-turn be used to retrieve previously stored data pertaining to the corresponding location on the surface, to store data pertaining to the corresponding location on the surface, to modify the behavior of the system incorporating the present invention, or to be presented to the user on a conventional display or printer device.

Detailed Description Paragraph Right (2):
In simple shaped surfaces, such as a rectangle, a minimum of three small electrical contacts mounted on the edge of the surface are needed. On more complex shaped surfaces the minimum number of electrical contacts may increase to enable the system to determine between multiple locations on the surface as to which one that the user is indicating. In each configuration of the surface, the contacts need to be positioned such that all locations on the surface can be individually identified.

Detailed Description Paragraph Right (4):
The present invention determines a user selected position on the surface by measuring the unique position indicating signals with a receiver as discussed below. For either two or three dimensional objects, the present invention only requires a single receiver circuit.

Detailed Description Paragraph Right (5):
In the various embodiments of the present invention, the stylus does not load, or negligibly loads, the transmitters and a signal level at the point on the surface that is touched by the stylus is measured rather than the changes in the driving circuit as in the Meadows device. Additionally, potentially phantom styluses such as fingers and rings, that have a dramatic effect on the operation of the prior art, only have a negligible loading effect on the transmitter of the present invention. Thus the present invention is immune to phantom styluses.

Detailed Description Paragraph Right (6):
In the present invention the active surface can be made of a conductive polymer composite (conductive plastic), or a conductive coating on a non-conductive material. This has substantial cost advantages over the prior art since no overlays or embedded wires are needed, and since the surface itself provides the necessary structural support. Devices incorporating the present invention would typically include a surface of a conductive polymer composite molded or vacuum formed that does not require any additional structure thus resulting in an additional cost of only the carbon-polymer material, or the applied conductive coating. Furthermore, the formation of the sensitive surface by injection molding allows for easy creation of touch sensitive complex shapes. The use of a carbon-polymer composite material as both an element in the position location system and the structural support provides a rugged and reliable system. Carbon-polymer composite materials are inherently rugged and the system of the present invention employs a single layer of such material, rather than a multi-layer system where the bonding between the layers may deteriorate and the layers separate.

Detailed Description Paragraph Right (7):
A minimum of three contacts are needed to drive an entire surface of a simple object (e.g., a rectangle, circle or ellipsoid). Additional contacts may be used for complex objects or to provide increased resolution for simpler shapes rather than increasing the sensitivity of the circuitry. The low number of contacts and therefore wire count, leads to low cost, ease of manufacturing, and enables remote or moveable surface applications (e.g., a rotating globe).

Detailed Description Paragraph Right (9):
Additionally, the present invention includes unique surface drive techniques that can compensate for unknown and variable contact resistance. Various contact types and mechanical connection mechanisms create contact resistances which vary substantially between contacts, and vary over time with mechanical and environmental stresses such as movement, temperature and aging. Other technologies rely on contacts of known, or constant, contact resistance with any uncompensated change in

contact resistance resulting in <u>position</u> detection errors.

<u>Detailed Description Paragraph Right</u> (11):
A second possible mechanism has just one electrode per contact and measures the value of the resistance of each contact to the resistive material of the surface. In such a system having three contact points, A, B and C, a signal level measurement is made at point C through a high impedance path while a signal of a known level is applied between point A and point B. Similar measurements are then made at point B with the signal applied between point C and point A, and at point A with the signal applied between point B and point C. Thus, knowing the <u>positions</u> of the contacts on the surface and the resistivity of the surface material, the contact resistance between points A, B, and C and the surface material may be calculated as discussed below with respect to FIG. 6.

<u>Detailed Description Paragraph Right</u> (12):
Additionally, the present invention incorporates the use of a multi-state drive sequence to provide quick measurement and on-the-fly calibration for improved accuracy. The <u>stylus</u> is used to make several signal measurements at a point on the surface of the object selected by the user. First a measurement is made with no signals applied to the contacts to determine a baseline DC offset and ambient noise level for the surface, for purposes of discussion here this is called DC-OFFSET. A second measurement is made with a signal applied to all of the contacts to determine the full-scale signal value, for purposes of discussion here this is called FULL-SCALE. Another measurement is then made by applying a signal to one pair of contacts to create a signal level gradient across the surface between those two points, for purposes of discussion here call this the X axis and the measured value X. A signal is then applied to another pair of contacts to create a signal level gradient in another direction, for purposes of discussion here call this the Y axis and the measured value Y. The following calculations are then made by the system to determine the selected <u>location</u> along the so defined X and Y axes on the surface.

<u>Detailed Description Paragraph Right</u> (13):
The actual <u>position</u> on the surface can then be determined from $P.sub.x$ and $P.sub.y$ by using a mathematical, or empirically determined, model of the signal level gradients for the surface material.

<u>Detailed Description Paragraph Right</u> (15):
The basis of the algorithm of the present invention is the use of triangulation to determine the <u>location</u> of the point on the surface of the object. Triangulation is defined as

<u>Detailed Description Paragraph Right</u> (16):
Triangulation is a basic tenet of trigonometry and its use in finding the <u>location</u> of a point on the surface of an object has been used for centuries. It is <u>used in</u> applications such as celestial navigation, surveying, the global positioning system (GPS), and seismology.

<u>Detailed Description Paragraph Right</u> (17):
In the present invention, as is the case in triangulation, <u>position</u> is determined by measuring the relationship at a point of interest to two known points. The relationship is determined from the <u>received</u> signal level at the <u>stylus</u> while injecting signals of known levels at the first two fixed points. All points on the surface that would have that signal level create a line of possible <u>positions</u>. Another relationship is determined using another two fixed points (a different pair of contacts however one contact can be one of those that was included in the first pair of contacts) and another <u>received</u> signal level from the <u>stylus</u>. The intersection of the two lines of possible <u>positions</u> from the two measurements thus tells us where the <u>stylus</u> touched the surface. For some surfaces this may be unique, such as a two dimensional surface or a hemisphere with the contacts mounted on the edge or at the equator.

<u>Detailed Description Paragraph Right</u> (18):
In theory any <u>position</u> in three dimensional space can be uniquely <u>identified</u> by its distance from four non-coplanar known points, while the number of <u>known points</u> required may be reduced in some cases if the possible <u>positions</u> in three dimensional

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space are constrained. For the purposes of the present invention the <u>position</u> of interest is constrained to lie on the surface of the known shape of the surface. For a shape such as a rectangle or a circle, a <u>position</u> on the surface may be defined by its distance from three known points on that surface, provided the known points are either all on the edge of the surface shape or not collinear. For the continuous surface shapes of spheres or ellipsoids, a <u>position</u> on the surface of the shape can be defined by its distance from three known points, provided the plane defined by the three known points does not include the center point of the shape. For a cylindrical shape a <u>position</u> on the surface can be defined by its distance from three known points, provided the plane defined by the three known points does not cross the center line of the cylinder.

<u>Detailed Description Paragraph Right</u> (20):
In practice more contact points may be used due to the finite resolution of real measurement devices. Another factor that may increase the number of contacts is cost. A trade off may be made between the resolution of the <u>receiver</u> and transmitter circuits, and the number of contacts between which the signal is applied to the surface for the measurements. If more contacts are used that are closer together then the resolution of the transmit/receive circuit may be reduced.

<u>Detailed Description Paragraph Right</u> (21):
The use of resistivity in materials to measure distance or <u>position</u> has been around for a number of years. An early example is the use of rotating, or sliding, potentiometers to determine the <u>position</u> of a knob or a slide.

<u>Detailed Description Paragraph Right</u> (24):
In FIG. 1 the basic components of the user selected <u>position locating</u> system of the present invention are shown. They include a two or three dimensional conductive surface 10 (e.g., carbon loaded plastic or a conductive coating applied to a non-conductive surface) having a selected resistivity with three conductive contacts 12, 14 and 16 affixed thereto. Each of contacts 12, 14 and 16 are connected via conductors 24, 26 and 28, respectively, to <u>processor</u> 30. Also connected to <u>processor</u> 30 is conductor 18 with a <u>stylus</u> 20 having a tip 22 affixed to the other end thereof for the user to use to indicate a <u>position</u> on surface 10 that is of interest to that user.

<u>Detailed Description Paragraph Right</u> (25):
Then, as in FIG. 2 when a user selects a point on surface 10 with <u>stylus</u> 20, a series of measurements as described in general terms above are made.

<u>Detailed Description Paragraph Right</u> (26):
In actual operation, each of those steps can be automated by <u>processor</u> 30 without requiring the user to initiate specific measurements or to switch signals.

<u>Detailed Description Paragraph Right</u> (27):
The values of P.sub.x and P.sub.y can then be used as an address to a memory within <u>processor</u> 30 from which information relative to the <u>position</u> indicated with the <u>stylus</u> may be obtained. This same technique can also be used to determine the address in memory where data is to initially be stored for later retrieval, or as an address on a remote display that is to be activated for whatever purpose.

<u>Detailed Description Paragraph Right</u> (28):
Each unique <u>position</u> on the surface is defined by a unique combination of values of P.sub.x and P.sub.y. From the series of measurements described above, the <u>position</u> <u>of the stylus</u> on the surface may be expressed in terms of P.sub.x and P.sub.y which will be called the equipotential coordinates. Additional calculations may also be made to convert the <u>position</u> from the equipotential coordinates to another coordinate system, if desired. The conversion requires a known mapping of the equipotential coordinates to the desired coordinate system. The mapping may be determined mathematically for an object made from a homogenous conductive material or one where the resistivity distribution is known. For objects in which the resistivity distribution is not known, the mapping of equipotential coordinates to the desired coordinates may be determined empirically. In either case, the mapping may be stored in the microprocessors memory and the conversion calculations performed by the microprocessor. FIG. 3 illustrates the same approach for

determining the values of P.sub.x and P.sub.y on the surface having a defining equation that is continuous over the entire surface, for example a hemisphere as shown.

Detailed Description Paragraph Right (33):
Signal generator 122 includes a 60 KHz AC signal generator 124 that feeds amplifier 134 with the noninverting output terminal of amplifier 134 connected to three separate terminals (one corresponding to each of contacts 102, 104 and 106) of switch 132, and the inverting output terminal of amplifier 134 connected to three terminals (one corresponding to each of contacts 102, 104 and 106) of switch 136. Then each of contacts 126, 128 and 130 are each connected to different terminals of each of switches 132 and 136. In FIG. 4 each of switches 132 and 136 are shown in the open position (i.e., no signal applied to any of contacts 126, 128 and 130).

Detailed Description Paragraph Right (34):
In turn, the position of each of switches 132 and 136 is controlled via cables 138 and 140, respectively, from microprocessor 142 to permit microprocessor 142 to select which of contacts 102, 104 and 106 receive a 60 KHz signal through switch 132 via the associated control lead and which of contacts 102, 104 and 106 receive an inverted 60 KHz signal through switch 136 via the associated control lead.

Detailed Description Paragraph Right (35):
When a 60 KHz AC signal is connected to one or more of contacts 102, 104 and 106 that signal radiates through the conductive material of sheet 100 and stylus 116 acts as an antenna when brought within proximity of surface 100. A signal detected by stylus 116 is in turn conducted to the signal measurement stage 120 via shielded cable 118. In this embodiment stylus 116 is completely passive and could be fabricated as simply as consisting of a plastic shell enclosing the end of shielded cable 118 with the final 1/8 inches of cable 118, at the distal end of stylus 116, having the shielding removed to allow the center conductor of cable 118 to be exposed to receive radiated signals. Thus, when the tip of the stylus is near the surface of conductive material 100, the radiated signal is received by the stylus antenna and provided as an input signal to signal measurement stage 120.

Detailed Description Paragraph Right (36):
Signal measurement stage 120 includes a demodulator 144 that is connected to cable 118 where the signal received by stylus 116 is demodulated and the demodulated signal is then in turn presented as a signal level to an analog-to-digital converter (ADC) 146. ADC 146 then digitizes that signal level and presents it to microprocessor 142.

Detailed Description Paragraph Right (37):
The use of an AC signal in this embodiment makes it possible for stylus 116 to receive signals radiated from the conductive material of sheet 100 without being in direct contact with the conductive material of sheet 100. This allows the conductive material of sheet 100 to be covered with a layer of a non-conductive material for protection from inevitable striking of the surface of sheet 100 with stylus 116, or for placement of application specific graphics over the touch surface, and still allow stylus 116 to act as an antenna to receive a signal from sheet 100 at a selected point that is to be measured by the signal measurement stage 120.

Detailed Description Paragraph Right (38):
Microprocessor 142 is encoded to direct the performance of a series of measurements with different sets of contacts 102, 104 and 106 connected to receive the 60 KHz signal, or the inverted 60 KHz signal.

Detailed Description Paragraph Right (39):
Once a user has selected a position on sheet 100 of interest, the system of the present invention performs a series of measurements in rapid succession (e.g., by time-division multiplexing) to determine the location to which stylus 116 is pointed and to provide the user with the information that is sought.

Detailed Description Paragraph Right (40):
The first measurement, as outlined above, is here called Signal.sub.OFFSET, and involves setting switches 132 and 136 to the all open positions. Microprocessor 142

then reads the signal level from signal measurement stage 120 and assigns that value to Signal.sub.OFFSET and saves that value in RAM 145.

Detailed Description Paragraph Right (42):
Next, microprocessor 142 selects a pair of contacts, say 102 and 104, for use in the next measurement. Contact 102, for this discussion is point A and is connected to receive the 60 KHz AC signal via switch 132. The other of those two contacts, contact 104, which for this discussion is point B is connected to receive the inverted 60 KHz AC signal via switch 136. The third contact 106 is merely connected to open switch sections in both of switches 132 and 136. Microprocessor 142 then stores the signal level from signal measurement stage 120 in RAM 145 and assigns that value the name Signal.sub.RAW-AB.

Detailed Description Paragraph Right (43):
Between the energized contacts 102 and 104, a signal level equipotential map 114A could be drawn due to the effect of the distributed resistance in the conductive material of sheet 100. Signal equipotential maps such as 114A, 114B, and 114C, including the shape and values of the equipotential signal level lines, are stored in ROM 147. As discussed in Electromagnetics, by John D. Kraus and Keith R. Carver, McGraw-Hill, 1973, pp 266-278, these signal equipotential maps are created by finding the unique solution to Laplaces equation (.gradient..sup.2 V=0) that satisfies the boundary conditions of sheet 100 and each pair of contacts. There are many methods of finding the solution to Laplace's equation for an object, including, but not limited to, direct mathematical solutions, graphical point-by-point computer modelling, and empirical determination. For homogenous conductive material and simple shapes, a direct mathematical solution may easily .be obtained. For materials whose homogeneity, shape or contact placement do not lend themselves to other methods, empirical determination may be used.

Detailed Description Paragraph Right (44):
In the empirical determination method, a coordinate system is chosen and overlaid on the device. To determine the map for a specific pair of contacts, such as 102 and 104, the contacts are energized in the same manner as for measuring Signal.sub.RAW-AB above. At each cross point on the chosen coordinate system the value of Signal.sub.RAW AB is measured. If the chosen cross point granularity is sufficiently fine the equipotential map may be extracted directly by finding the points that contain the same measured value. Otherwise the equipotential lines may be calculated by interpolating between measured points.

Detailed Description Paragraph Right (45):
For the third measurement, microprocessor 142 selects another pair of contacts, such as 102 and 106. Contact 102, as discussed above will again be referred to as point A, is connected to receive the 60 KHz AC signal via switch 132 and is the only one of the contacts so connected. The other contact 106, which for this discussion is referred to a point C, is connected to the inverse 60 KHz signal via switch 136. Microprocessor 142 then records the signal level from signal measurement stage 120 and assigns that value the name Signal.sub.RAW-AC.

Detailed Description Paragraph Right (46):
The two signals, Signal.sub.RAW-AB and Signal.sub.RAW-AC, are affected not only by the material resistance between the contacts but by a number of other factors including the altitude of stylus 116 from the surface of the conductive material of sheet 100, the attitude or angle of stylus 116, and changes in the circuitry from environmental changes, aging, or other factors. The signal, Signal.sub.FULL, is similarly affected by altitude, attitude, and circuitry changes but has a constant signal equipotential map, thus the value of Signal.sub.FULL may be used to normalize the values of Signal.sub.RAW-AB and Signal.sub.RAW-AC to remove the effects of altitude, attitude, and circuitry changes using the following formula.

Detailed Description Paragraph Right (49):
For example, using the predetermined signal map 114A and the value Signal.sub.NORM-AB, the position of stylus 116 may be resolved to a single signal level line, such as 115, between contacts 102 and 104.

Detailed Description Paragraph Right (50):

Using the predetermined signal map 114B and the value Signal.sub.NORM-AC, another signal level line in the signal map 114B can be determined between contacts 102 and 106. The position of stylus 116 is then resolved to the point, P, where the signal level line selected by Signal.sub.NORM-AB in 114A crosses the signal level line selected by Signal.sub.NORM-AC in 114B.

Detailed Description Paragraph Right (51):
The use of the resolved point, P, is qualified by microprocessor 142 by comparing the value of Signal.sub.FULL to a predetermined threshold level to determine if the received signal is valid. This threshold is generally determined empirically to satisfy the resolution requirements of the application or the user. As the altitude of stylus 116 from the surface of the conductive material of sheet 100 is reduced, the received signal is stronger and the resolution of the position is more precise. Some applications such as drawing tablets, may want a specific altitude threshold in order to match user expectations of operation. In these applications, users do not expect the system to acknowledge the stylus position until the tip is in contact with the surface. Other applications may desire a higher or lower degree of resolution. The application may select the altitude threshold that best matches it's requirements. When a Signal.sub.FULL threshold for a particular application is satisfied the resolved point, P, is considered valid.

Detailed Description Paragraph Right (52):
The measurements outlined above are made in succession and each measurement can typically be made within 4 msec so the entire sequence is completed in 12-16 msec. This is important since the measurement sequence needs to be completed quickly so that any stylus position changes between the measurements are minimized. Substantially faster sample times may be used provided that the capabilities of the signal measurement device are selected accordingly.

Detailed Description Paragraph Right (53):
To support an application that requires a series of stylus locations in quick succession to be measured, a sample time that is substantially faster than the movement of the stylus needs to be chosen. An application that would require successive stylus location detection would be an electronic drawing pad where the succession of points would form a line. An application of this type may require sample times on the order of 200 microseconds.

Detailed Description Paragraph Right (54):
In the embodiment discussed above, signal generator 122 produces a 60 KHz AC signal, however, a DC voltage level could alternatively be used. With a DC signal level in lieu of the 60 KHz signal the ability to detect the position of the stylus without making contact between stylus 116 and the conductive material of sheet 100 is eliminated. Since direct contact is made between the stylus and the material, the effects of the altitude and attitude of the stylus no longer contribute to the measurement of Signal.sub.RAW since stylus altitude and attitude are the dominant source of variation in the measurement of Signal.sub.RAW. The elimination of stylus altitude and attitude from the measurement reduces, or eliminates, the need to normalize Signal.sub.RAW with Signal.sub.FULL.

Detailed Description Paragraph Right (55):
More measurements (contacts 104 to 106, i.e., B to C) may also be made to refine/confirm the point to which stylus 116 is being pointed with a minimum number of measurements. Microprocessor 142 could also be programmed to filter measurements to dampen changes made by movement of stylus 116 and to increase resolution.

Detailed Description Paragraph Right (56):
Synchronous detection techniques in the receive demodulator substantially improve noise immunity. The received signal is multiplied by the transmitted signal with a FET switch (e.g., DG441). The resulting multiplied signal is then integrated to determine the DC component. It is the integrated signal that is presented to the ADC for conversion. The net effect of the multiplication and integration is that only received signals of the same frequency and phase to the transmitted signal are seen. Such signals are considered to be synchronous with the transmitter, and therefore the name synchronous demodulation. Effective noise immunity is accomplished since, in general, sources of noise will not be synchronized to the transmitter, and

therefore will not be seen after multiplying and integrating. Only the desired portion of the transmitted signal that has been detected by the <u>receiving stylus</u> will be measured.

<u>Detailed Description Paragraph Right</u> (58):
In cases where two electrically isolated surfaces terminate along the same edge, such as the equator on a <u>globe</u> made of isolated Northern and Southern hemispheres, similar techniques can be used to improve positional accuracy near the edge. In such cases distance from the edge can be estimated by comparing Signal.sub.FULL from both surfaces, and using the ratio of Signal.sub.FULL-A to Signal.sub.FULL-B to help eliminate the effects of altitude and attitude.

<u>Detailed Description Paragraph Right</u> (59):
Once the <u>position</u> indicated by the user is determined, the system might be employed in an application where information relative to that <u>position</u> has been pre-stored, or is to be stored, in the overall system. To enable that application, RAM 145, ROM 147, audio/video card 150 and CD ROM drive 156 are shown interfacing with microprocessor 142 via a data bus. For example, if surface 100 has an overlay of a <u>map</u> there may be information prestored in ROM 147 or on a CD in CD ROM drive 156 that can be delivered to the user in either audio or visual form via audio/video card 150 and speaker 154 or monitor 152.

<u>Detailed Description Paragraph Right</u> (60):
The contact resistance of the connections between contacts 102, 104 and 106 and the conductive material of sheet 100 may play a significant role in defining the absolute signal levels in the signal <u>maps</u> (114A, 114B and 114C). That contact resistance affects the absolute value of the signal level but has only a minor effect on the shape or distribution of signal lines. In some cases the contact resistance between one contact and the conductive material of sheet 100 may be of a similar, or a higher, value than the resistance through the conductive material between different contacts. The resistance between a single contact and the conductive material is also subject to change over time due to chemical, or mechanical factors. Contact to conductive material resistance may also differ from unit to unit in a manufactured product.

<u>Detailed Description Paragraph Right</u> (66):
An alternate mechanism for compensating for contact resistance is to determine the current value of the contact resistance and adjust the absolute values in the signal <u>map</u> based on any change in contact resistance value. The embodiment shown in FIG. 6 performs that function.

<u>Detailed Description Paragraph Right</u> (67):
Again comparing the embodiments of FIGS. 4 and 6, several similarities can be noted which include sheet 100 with contacts 102, 104 and 106, <u>stylus</u> 116 and shielded cable 118, signal measurement stage 120, microprocessor 142 and associated components, and signal generator 122. The new component here is four <u>position</u> switch 301 which provides selectability as to which signal is input to the input terminal of demodulator 144 of the signal measurement stage 120 under control of microprocessor 142 via line 302. The four potential signal input sources are <u>stylus</u> 116 and any one of contacts 102, 104 and 106 on sheet 100.

<u>Detailed Description Paragraph Right</u> (68):
For any <u>position</u> in the signal <u>map</u> between two points, any change in the resistance of any contact through which current is flowing will modify the signal value observed. For example, for a predetermined, or calculated, signal <u>map</u> such as 114A between contacts 102 and 104 in FIG. 4, a change in the contact resistance at contact 102 will change the absolute values in the signal <u>map</u> but not the distribution or shape of the signal <u>map</u>. If the contact resistance at 104 were to change and the new contact resistance measured, the microprocessor could adjust the predetermined, or calculated, signal <u>map</u> to compensate for the changed contact resistance.

<u>Detailed Description Paragraph Right</u> (69):
To measure and calculate the contact resistance changes at the three contacts 102, 104, and 106 in FIG. 6, three additional measurements are made. These measurements

may be added to the sequence of measurements of Signal.sub.FULL, Signal.sub.OFFSET, Signal.sub.RAW-AB and Signal.sub.RAW-AC. For this discussion the contacts will be designated A, B, and C for contacts 102, 104, and 106. For the first additional measurement the microprocessor selects contact 102 to be connected to the 60 KHz AC signal via switch 132, and contact 104 to be connected to the inverted 60 KHz AC signal via switch 136. The signal measurement device is connected to a fixed location, contact 106, via switch 301. The microprocessor then stores the signal level from the signal measurement stage in RAM as Signal.sub.C.

Detailed Description Paragraph Right (73):
An alternate mechanism to driving a pair of contacts and sensing with a <u>receiver</u> connected to the <u>stylus is to use the stylus</u> and one of the contacts as the driving mechanism and to perform sensing with one of the other contacts. A sequence of measurements could be made where another contact is selected as the drive contact and yet another contact is selected as the sense contact.

Detailed Description Paragraph Right (74):
An alternate drive and measurement method is provided by the use of frequency division multiplexing. Previously discussed methods include a series of measurement steps separated in time. In a frequency division multiplexing method, pairs of contact points are driven simultaneously with different frequency signals. Therefore the signal <u>received by the stylus</u> is a composite of those different frequency signals and thus is distributed to multiple independent signal measurement devices (i.e., sorted by frequency) that each measure the corresponding signal simultaneously. The multiple measurement devices in this embodiment are designed to measure signals within narrow frequency bands. This measurement method offers the possibility of measuring the <u>position</u> in less time however with a more complicated signal drive and measurement <u>detection</u> system.

Detailed Description Paragraph Right (75):
Several design tradeoffs may be made in the implementation of the present invention for use in a specific device. To enhance resolution a higher resolution signal generation and measurement scheme may be used. Alternately the number of contact points may be increased and an enhanced algorithm implemented that uses subsets of the contact points to resolve <u>stylus</u> touches on different areas of the surface. Another alternative might be the selection of a conductive material and manufacturing method that provides a more homogenous resistivity in the surface. This increases the resolution and allows for calculated, rather than measured signal <u>maps</u>. If the material used is not homogenous, another way that higher resolution may be accomplished is by measuring a more comprehensive signal <u>map</u> that is stored in the microprocessor memory.

Detailed Description Paragraph Right (76):
The embodiments described in FIGS. 4, 5, 6, and 7 include a <u>stylus</u> that is tethered to the rest of the detection system by conductor 118. This conductor may be replaced with a communications link that does not require tethering the <u>stylus</u> to the system with a conductor. A low power RF transmitter could be embedded or attached to the <u>stylus</u> and a compatible RF <u>receiver</u> attached to the signal measurement means. The RF transmitter and <u>receiver</u> would then implement the communications link that conductor 118 provided.

Detailed Description Paragraph Right (78):
In another embodiment as shown in FIG. 7, the <u>position of stylus</u> 116 on a sphere may be detected. In this embodiment a sphere 400, molded from a conductive material of the same type discussed for each of the other embodiments, has four contacts 401, 402, 403 and 404 attached to it. In order to be able to individually distinguish each point on the surface of a closed three dimensional shape (e.g., a sphere) the contacts must be positioned such that each plane defined by each possible combination of any three of those contact points does not pass through the center of the sphere. How close these imaginary planes can come to the center of the sphere (i.e., the placement of the contacts) is determined by the resolution of the signal measurement device and the precision of the predetermined, or calculated, signal equipotential <u>map</u> that determines the point to which the <u>stylus</u> is pointed.

Detailed Description Paragraph Right (79):

The calculation of position is therefore substantially the same as discussed with respect to a pair of contacts thus that discussion and the claims also include this variation.

Detailed Description Paragraph Right (80):
To resolve the position of stylus 116 on the two dimensional area of the rectangular sheet 100 in the embodiment of FIG. 4, three measurements, Signal.sub.FULL, Signal.sub.RAW-AB, and Signal.sub.RAW-AC were required since, as described above with respect to FIG. 2, the equipotential lines for each of the AB and AC measurements can only cross in one point. For a sphere as in FIG. 7, however, four measurements are required to fully resolve the position. For example, if contact 401 is point A, contact 402 is point B, contact 403 is point C and contact 404 is point D, a measurement of Signal.sub.FULL with all four points driven simultaneously is one measurement, and three measurements from the six possible pair combinations of the four contacts must be made, namely three of the possible measurements Signal.sub.RAW-AB, Signal.sub.RAW-AC, Signal.sub.RAW-AD, Signal.sub.RAW-BC, Signal.sub.RAW-BD, or Signal.sub.RAW-CD. Calculating the three Signal.sub.NORM as in equation (3) above and plotting those values on the applicable signal maps will uniquely resolve all points on the sphere. When two Signal.sub.NORM values are plotted, the equipotential lines intersect in two places 'on opposite sides of the sphere. The third Signal.sub.NORM value is used to determine which of the two intersect points is the one to which the stylus is being pointed. Specifically, if the signal measured at the fourth point where used with the signal from one of the other two points that were used to locate the first two alternative points, that combination would also result in two possible points on the sphere, however, one of those two points would correspond with one of the two previously determined points and it is that corresponding point that is the actual point of interest on the sphere.

Detailed Description Paragraph Right (81):
An alternative to using a stylus as the pointing device is the use of a finger as the pointing device. To enable this, a multi-layer material constructed with the inner layer being similar to the conductive material discussed in the previous embodiments may be used. Such a surface is illustrated in FIG. 10 with conductive layer 100 on the bottom, a flexible conductive layer 501 on top (e.g., a metal foil or a thin layer of a conductive polymer), and a compressible non-conductive layer 502 (e.g., silicon rubber or plastic foam) in-between layers 100 and 501. Outer layer 501 may be metal, or some conductive material.

Detailed Description Paragraph Right (82):
In this configuration, outer conductive layer 501 replaces the attached stylus 116 as in FIG. 4 with outer layer 501 connected to the signal measurement device by conductor 118 (e.g., see FIG. 4). Thus, when a user touches outer layer 501, the middle non-conductive layer 502 compresses and conductive outer layer 501 is brought closer to conductive inner layer 502. In that situation, the signal level received by outer layer 501 from the radiated signals on inner layer 100 increases in much the same way as the signal level received by stylus 116 increases as the altitude of stylus 116 is decreased relative to surface 100 in FIG. 4. In the embodiment that utilizes the multi-layer surface, the position of the user's finger would be calculated in the same way as the location of the stylus with a threshold value chosen for Signal.sub.FULL in the signal valid determination step that corresponds to a fully depressed outer layer.

Detailed Description Paragraph Right (83):
As mentioned briefly above with respect to FIG. 4, one application of the present invention might be an interactive globe of the earth, the moon, one of the planets, one of the stars, or even an artificial body or planet for an interactive game. Two potential implementations of such a globe are illustrated in FIGS. 11 and 12. The primary differences between the embodiments of those figures is that in FIG. 11 the conductive surface is a sphere, and in FIG. 12 the conductive surface is implemented with two hemispheres.

Detailed Description Paragraph Right (84):
FIG. 11 illustrates the system disclosed above with respect to FIG. 7 being modified to be a world globe. Thus, the electronics in the lower portion of FIG. 11 have the

same reference numbers as, and operate in the same way described, in FIG. 7. In FIG. 11 there is a conductive sphere 603 with four contact points 604, 605, 606 and 607 on the inside of sphere 603, with each of the contact points connected, respectively, to one of the four insulated conductors of cable 608 at one end of those conductors. Cable 608 exits sphere 603 through a small hole in the bottom of sphere 603 with the other end of the conductors of cable 608 interconnecting with the corresponding sections of switches 422 and 432.

Detailed Description Paragraph Right (85):
To provide the geographic details of the globe, two vinyl skins 601 and 602, shown here as representing the northern and southern hemispheres of the earth, are placed over sphere 603. thus when a user uses stylus 116 to point to a location on the globe, the electronics determines the coordinates of that selected location as described above in the discussion with respect to FIG. 7 since the electronics here are as described there. The unique location on the surface of the globe is thus defined by the equipotential coordinates which can then be mapped by microprocessor 142 (e.g., by means of a look-up table) into global coordinates (e.g., longitude and latitude) that correspond to the selected position on the globe.

Detailed Description Paragraph Right (86):
A database containing features of interest in the world, such as country locations and names, capitals, and populations can be prestored in RAM 145 relative to what ever coordinate system is desired. Thus, when a user selects a point on the globe with stylus 116, microprocessor 142 determines the coordinates of that position and causes the retrieval of information relative to that position from the database to be presented to the user via, for example, audio/video card 150 and speaker 154.

Detailed Description Paragraph Right (87):
An alternative implementation of a world globe is illustrated in FIG. 12 where conductive hemispheres 701 and 702, that are electrically isolated from each other, provide the conductive surfaces for the globe. Here hemispheres 701 and 702 are bonded together with their edges in close proximity to each other with one continuous, or several (e.g., three) rigid, non-conductive spacer(s) affixed to the edges of each of hemispheres 701 and 702 to maintain the spaced-apart relationship and the electrical isolation. Alternatively a non-conductive adhesive can be used between the edges of hemispheres 701 and 702. Then vinyl skins 601 and 602 with the geographical information are mounted over the two hemispheres as discussed above with respect to FIG. 11.

Detailed Description Paragraph Right (89):
By comparing FIG. 12 with FIG. 4 it can be seen that while the embodiment of FIG. 4 is for a single surface and FIG. 12 is for a pair of surfaces, the only wiring change between the signal generator of each embodiment is the addition of a second pair of switches for the second surface for the embodiment of FIG. 12. The remainder of the signal generator in each instance is the same with amplifier 134 connected to both pair of switches 770 and 771, and 772 and 773. This is possible since there is only one stylus 116 and only one point on the globe can be selected at one time (i.e., the selected point can only be on one hemisphere at a time). Thus, each hemisphere is treated as an independent location detection surface.

Detailed Description Paragraph Right (90):
To make a determination as to which of hemispheres 701 and 702 the user has pointed stylus 116, microprocessor 142 is programmed to make a series of measurements. First, as in many of the embodiments discussed above, with stylus 116 pointing at the selected point on one of the hemispheres, Signal.sub.FULL and Signal.sub.OFFSET are measured for each hemisphere independently, and then the difference between those measured values for each hemisphere (i.e., Signal.sub.FULL-701 -Signal.sub.OFFSET-701, and Signal.sub.FULL-702 -Signal.sub.OFFSET-702) is determined and stored in RAM 145. In short, Signal.sub.FULL is measured by applying the 60 KHz AC signal to all of the contact points on the surface, and Signal.sub.OFFSET is measured will all of the corresponding switch contacts in signal generator 722 for that surface open. Once those difference values are determined, each of those difference values is compared to a pre-selected threshold value. The threshold value is determined empirically and typically are the value measured when the stylus tip is within 0.10 inches from the surface. It is then

noted which, if any, of those difference values exceeds the threshold and does so with the greatest margin with the corresponding hemisphere being _identified_ as the one to which _stylus_ 116 is being pointed.

Detailed Description Paragraph Right (91):
Once the hemisphere of interest has been determined, microprocessor 142 then calculates the _position_ selected by the sequence of calculations outlined above with respect to FIG. 4. Thus, four measurements, Signal.sub.FULL, Signal.sub.OFFSET, Signal.sub.RAW-AB and Signal.sub.RAW-AC are made on the _identified_ hemisphere and the values of Signal.sub.NORM-AB and Signal.sub.NORM-AC are calculated as in equation 4 with those values defining a unique _location_ on that hemisphere.

Detailed Description Paragraph Right (92):
The unique _location_ provided by the values of Signal.sub.NORM-AB and Signal.sub.NORM-AC, together with the results of the threshold test to determine which hemisphere is of interest to the user, may then be mapped into a _location on the globe_ by means of a look-up table for the selected hemisphere, if necessary, to obtain the longitude and latitude of the point selected, in a standard _globe_ coordinate system. Then, as discussed with respect to FIG. 11, microprocessor 142 can present the user with information relative to the selected point from memory via audio video card 150 and speaker 154, or by any other desired media (e.g., _printer,_ monitor, etc.) or combinations of media.

Detailed Description Paragraph Type 1 (1):
"The _location_ of an unknown point, as in navigation, by the formation of a triangle having the unknown point and two known points as the vertices." (The American Heritage Dictionary of the English Language, Third Edition)

Detailed Description Paragraph Type 1 (2):
First, without any signals applied to contacts 12, 14 and 16, _processor_ 30 measures the DC-OFFSET value of the system with _stylus_ 20;

Detailed Description Paragraph Type 1 (3):
Next an equal amplitude signal is applied to all three of contacts 12, 14 and 16, and _processor_ 30 measures the FULL-SCALE signal value with _stylus_ 20;

Detailed Description Paragraph Type 1 (4):
The third measurement is made by applying a signal of the amplitude used in the full-scale measurement to one of the three contacts, say contact 12 with a second contact grounded, say contact 14, and the signal measurement made with _stylus_ 20 which will be somewhere along an equipotential line between those two contacts (i.e., line X in FIG. 2);

Detailed Description Paragraph Type 1 (5):
A fourth measurement is made by applying the signal to, and grounding, a different pair of contacts, say 12 and 16, and the signal measurement made with _stylus_ 20 which will be somewhere along an equipotential line between those two contacts (i.e., line Y in FIG. 2), with the _position of stylus_ 20 being the intersection of lines X and Y; and

CLAIMS:

1. An electrographic _sensor_ unit for use in determining the _position_ of a selected point, which comprises:

a layer of a conductive material having an electrical resistivity and a surface;

three spaced apart contact points electrically interconnected with said layer of conductive material;

a _processor_ connected to said three spaced apart contact points and disposed to selectively apply a signal to each of said three spaced apart contact points; and

a probe assembly, including a _stylus,_ coupled to said _processor, said stylus_ disposed to be positioned by a user in vicinity of a user selected point on said

surface of said layer and to receive signals from said layer when said three spaced apart contact points have signals selectively applied thereto;

wherein said position of said stylus relative to said surface of said layer is determinable by said processor from signals received from said stylus each in relation to a similar excitation of two different pairs of said three spaced apart contact points under control of said processor.

2. The electrographic sensor unit of claim 1 further includes an insultative layer placed on an exposed surface of said layer of conductive material.

3. The electrographic sensor unit of claim 1 wherein said layer of conductive material is a carbon-polymer composition material.

4. The electrographic sensor unit of claim 3 wherein said layer is in the form of a two or three dimensional shape.

5. The electrographic sensor unit as in claim 1 wherein said layer of conductive material has a defined edge and is formed into a two or three dimensional shape.

6. The electrographic sensor unit of claim 5 wherein said three spaced apart contact points are placed on said layer of conductive material such that all points of interest to a user that may be designated by pointing said stylus thereat such that each point of interest is in the field of view of two different pair of said three spaced apart contact points.

7. The electrographic sensor unit of claim 6 wherein the included angle at each contact point of each pair of said three spaced apart contact points is less than 90.degree., with the included angle being that angle defined by the vectors between said pair of contact points, and said contact point corresponding to said included angle and said point of interest to which said stylus is being pointed by said user.

8. The electrographic sensor unit of claim 7 further includes an insultative layer placed on an exposed surface of said layer of conductive material.

9. The electrographic sensor unit of claim 7 wherein said layer of conductive material is a carbon-polymer composition material that is formed into a two or three dimensional shape.

10. The electrographic sensor unit of claim 7 wherein:

each of said three spaced apart contact points includes a tandem pair of contacts with a first of said tandem pair of contacts connected to said processor to receive signals to be applied to said layer and a second of said tandem pair of contacts connected to said processor from which measurements of signals is to be made; and

said processor includes three amplifiers each associated with a different one of said three spaced apart contact points and each having one output terminal and two input terminals, said output terminal coupled to said first of said tandem pair of contacts of the associated one of said three spaced apart contact points, one of said input terminals connected to said second of said tandem pair of contacts of the associated one of said three spaced apart contact points, and said second input terminal connected to receive said signals that are selectively applied by said processor to the corresponding one of said three spaced apart contact points.

11. The electrographic sensor unit of claim 7 wherein:

said processor includes a four position switch connected to receive signals to be measured by said processor individually from said probe assembly and each of said three spaced apart contact points, said signal measurements of signals from each of said three spaced apart contact points when the other two of said three spaced apart contact points are powered by said processor to enable said processor to determine contact resistance, and changes in contact resistance, of each of said three spaced apart contact points; and

said <u>processor</u> calculates the contact resistance of each of said three spaced apart contact points by first injecting a known signal between each pair of said three spaced apart contact points and measuring a resultant signal at the third of said three spaced apart contact points and then solving the following simultaneous equations for the contact point resistance values,

$Signal.sub.C =Signal.sub.IN [(X.multidot.R.sub.AB +R.sub.B)/(R.sub.AB +R.sub.B +R.sub.A)];$

$Signal.sub.B =Signal.sub.IN [(Y.multidot.R.sub.AC +R.sub.C)/(R.sub.AC +R.sub.C +R.sub.A)]; and$

$Signal.sub.A =Signal.sub.IN [(Z.multidot.R.sub.BC +R.sub.C)/(R.sub.BC +R.sub.C +R.sub.B)];$

where:

said three spaced apart contact points are <u>identified</u> in these equations as A, B and C;

Signal.sub.IN is the signal injected by said <u>processor</u> between each pair of contact points;

R.sub.AB, R.sub.AC and R.sub.BC are the bulk resistance values of the layer of conductive material between the corresponding contact points of said resistances;

X, Y and Z are the fractions of the bulk resistance values between the respective contact points given the user selected point between each pair of contact points AB, AC and BC; and

R.sub.A, R.sub.B and R.sub.C are the contact resistance values at those respective contact points.

12. The electrographic <u>sensor</u> unit of claim 7 wherein said <u>position of said stylus</u> is determined by said <u>processor</u> causing selected signals to be applied to various combinations of said three spaced apart contact points and a measured signal received by said stylus in response to each application of signals that are used by said <u>processor</u> to calculate the <u>position to which said stylus</u> is pointed by the user:

a first measurement is made by open circuiting each of said three spaced apart contact points and measuring an offset signal, Signal.sub.OFFSET, with said <u>stylus</u>;

a second measurement is made by applying the same signal to each of said three spaced apart contact points and measuring a full signal, Signal.sub.FULL, with said <u>stylus</u>;

a third measurement is made by applying a signal between a first two of said three spaced apart contact points with the other contact point left unconnected, the value of the signal applied between said first two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said first two contact points, Signal.sub.RAW-FIRST-TWO, with said <u>stylus</u>;

a fourth measurement is made by applying a signal between a second two of said three spaced apart contact points with the other contact point left unconnected, the value of the signal applied between said second two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said second two contact points, Signal.sub.RAW-SECOND-TWO, with said <u>stylus</u>;

calculating the relative <u>position to which the stylus</u> is pointed by the user relative to said first two contact points and said second two contact points using the following equations, the values from those equations being coordinates on an

equipotential map of the user selected point to which the user is pointing said stylus with the axes of those coordinates being imaginary lines between each of said first two contact points and said second two contact points:

$P.sub.FIRST\text{-}TWO = (Signal.sub.RAW\text{-}FIRST\text{-}TWO - Signal.sub.OFFSET)/(Signal.sub.FULL - Signal.sub.OFFSET);$

and

$P.sub.SECOND\text{-}TWO = (Signal.sub.RAW\text{-}SECOND\text{-}TWO - Signal.sub.OFFSET)/(Signal.sub.FULL - Signal.sub.OFFSET);$

a predetermined signal map of said layer of conductive material is prestored in said processor; and

said calculated values of P.sub.FIRST-TWO and P.sub.SECOND-TWO are used by said processor in conjunction with said signal map to translate said calculated values into a physical position on said surface to which said user is pointing said stylus.

13. The electrographic sensor unit of claim 7 wherein:

said layer of conductive material is formed into a closed three dimensional shape;

said electrographic sensor unit further includes a fourth contact point spaced apart from said three spaced apart contact points and electrically interconnected with said layer of conductive material;

said position of said stylus is determined by said processor causing selected signals to be applied to various combinations of said four spaced apart contact points and a measured signal received by said stylus in response to each application of signals that are used by said processor to calculate the position to which said stylus is pointed by the user,

a first measurement is made by open circuiting each of said four spaced apart contact points and measuring an offset signal, Signal.sub.OFFSET, with said stylus;

a second measurement is made by applying the same signal to each of said four spaced apart contact points and measuring a full signal, Signal.sub.FULL, with said stylus;

a third measurement is made by applying a signal between a first two of said four spaced apart contact points with the other two contact points left unconnected, the value of the signal applied between said first two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said first two contact points, Signal.sub.RAW-FIRST-TWO, with said stylus;

a fourth measurement is made by applying a signal between a second two of said four spaced apart contact points with the other two contact points left unconnected, the value of the signal applied between said second two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said second two contact points, Signal.sub.RAW-SECOND-TWO, with said stylus;

a fifth measurement is made by applying a signal between a third two of said four spaced apart contact points with the other two contact points left unconnected, the value of the signal applied between said third two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between those said third two contact points, Signal.sub.RAW-THIRD-TWO, with said stylus; and

calculating the relative position to which said stylus is pointed by the user relative to said first two contact points, said second two contact points, and said third two contact points using the following equations, the values from those

equations being coordinates on an equipotential <u>map</u> of the user selected point to which the user is pointing said <u>stylus</u> with the axes of those coordinates being imaginary lines between each of said first two contact points, said second two contact points, and said third two contact points:

P.sub.FIRST-TWO =(Signal.süb.RAW-FIRST-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET);

P.sub.SECOND-TWO =(Signal.sub.RAW-SECOND-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET);

and

P.sub.THIRD-TWO =(Signal.sub.RAW-THIRD-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET);

a predetermined signal <u>map</u> of said conductive material is prestored in said <u>processor</u>; and

said calculated values of P.sub.FIRST-TWO, P.sub.SECOND-TWO, and P.sub.THIRD-TWO are used by said <u>processor</u> in conjunction with said signal <u>map</u> to translate said calculated values into a physical <u>position</u> on said surface to which said user is pointing said <u>stylus</u>.

14. The electrographic <u>sensor</u> unit of claim 7 wherein said <u>processor</u> includes:

a microprocessor having a data bus associated therewith;

a memory system interfacing with said data bus;

a signal generator stage coupled to said microprocessor to generate and apply various signals to various ones, and various combinations, of said three spaced apart contact points under control of said microprocessor; and

a signal measurement stage coupled to said microprocessor and said probe assembly to capture and condition signals <u>received</u> from said probe system under control of said microprocessor.

15. The electrographic <u>sensor</u> unit of claim 14 wherein said signal generator stage includes:

a signal generator; and

a switching system coupled between said signal generator and said three spaced apart contact points on said layer to selectively apply a signal from said signal generator to selected ones of said three spaced apart contact points under the direction of said microprocessor.

16. The electrographic <u>sensor</u> unit of claim 15 wherein:

said memory system includes prestored information relative to various coordinates on said layer; and

said <u>processor</u> further includes:

an electronic delivery system to provide information from said memory system to said user relative the user selected <u>position of said stylus</u>.

17. The electrographic <u>sensor</u> unit of claim 1 wherein said three spaced apart contact points are noncollinear.

18. The electrographic <u>sensor</u> unit of claim 1 wherein: said <u>stylus</u> includes an electrically conductive portion; and

said probe assembly further includes:

an electrically conductive cable connected between said electrically conductive portion and said processor.

19. The electrographic sensor unit of claim 18 wherein:

said processor selectively applies AC signals to selected ones of said three spaced apart contact points; and

said stylus electrically conductive portion detects signals radiated from said layer of conductive materials as an antenna without making physical contact with said layer.

20. The electrographic sensor unit of claim 18 wherein:

said processor selectively applies DC signals to selected ones of said three spaced apart contact points; and

said stylus electrically conductive portion detects signals from said layer of conductive materials by making physical contact with said layer.

21. The electrographic sensor unit of claim 1 wherein:

said stylus includes an electrically conductive portion; and

said probe assembly further includes:

a transmitter mounted on said stylus and connected to said electrically conductive portion to transmit a signal encoded with information proportional to a value of a signal detected by said electrically conductive portion when brought into the vicinity of said conductive layer; and

a receiver coupled to said processor to receive signals from said transmitter and to present the information encoded in said signal transmitted by said transmitter into a signal compatible with said processor.

22. The electrographic sensor unit of claim 21 wherein:

said processor selectively applies AC signals to selected ones of said three spaced apart contact points; and

said electrically conductive portion of said stylus detects signals radiated from said layer of conductive materials as an antenna without making physical contact with said layer.

23. The electrographic sensor unit of claim 21 wherein:

said processor selectively applies DC signals to selected ones of said three spaced apart contact points; and

said electrically conductive portion of said stylus detects signals from said layer of conductive material by making physical contact with said layer.

24. The electrographic sensor unit of claim 1 wherein:

each of said three spaced apart contact points includes a tandem pair of contacts with a first of said tandem pair of contacts connected to said processor to receive signals to be applied to said layer and a second of said tandem pair of contacts connected to said processor from which measurements of signals is to be made; and

said processor includes three amplifiers each associated with a different one of said three spaced apart contact points and each having one output terminal and two input terminals, said output terminal coupled to said first of said tandem pair of contacts of the associated one of said three spaced apart contact points, one of said input terminals connected to said second of said tandem pair of contacts of the

associated one of said three spaced apart contact points, and said second input terminal connected to <u>receive</u> said signals that are selectively applied by said <u>processor</u> to the corresponding one of said three spaced apart contact points.

25. The electrographic <u>sensor</u> unit of claim 1 wherein said <u>processor</u> includes a four <u>position</u> switch connected to <u>receive</u> signals to be measured by said <u>processor</u> individually from said probe assembly and each of said three spaced apart contact points, said signal measurements of signals from each of said three spaced apart contact points when the other two of said three spaced apart contact points are powered by said <u>processor</u> to enable said <u>processor</u> to determine contact resistance, and changes in contact resistance, of each of said three spaced apart contact points.

26. The electrographic <u>sensor</u> unit of claim 25 wherein said <u>processor</u> calculates the contact resistance of each of said three spaced apart contact points by first injecting a known signal between each pair of said three spaced apart contact points and measuring a resultant signal at the third contact point and then solving the following simultaneous equations for the contact point resistance values,

Signal.sub.C =Signal.sub.IN [(X.multidot.R.sub.AB +R.sub.B)/(R.sub.AB +R.sub.B +R.sub.A)];

Signal.sub.B =Signal.sub.IN [(Y.multidot.R.sub.AC +R.sub.C)/(R.sub.AC +R.sub.C +R.sub.A)]; and

Signal.sub.A =Signal.sub.IN [(Z.multidot.R.sub.BC +R.sub.C)/(R.sub.BC +R.sub.C +R.sub.B)];

where:

said three spaced apart contact points are <u>identified</u> in these equations as A, B and C;

Signal.sub.IN is the signal injected by said <u>processor</u> between each pair of contact points;

R.sub.AB, R.sub.AC and R.sub.BC are the bulk resistance values of the layer of conductive material between the corresponding contact points of said resistances;

X, Y and Z are the fractions of the bulk resistance values between the respective contact points given the user selected point between each pair of contact points AB, AC and BC; and

R.sub.A, R.sub.B and R.sub.C are the contact resistance values at those respective contact points.

27. The electrographic <u>sensor</u> unit of claim 1 wherein said <u>position of said stylus</u> is determined by said <u>processor</u> causing selected signals to be applied to various combinations of said three spaced apart contact points and a measured signal <u>received by said stylus</u> in response to each application of signals that are used by said <u>processor</u> to calculate the <u>position to which said stylus</u> is pointed by the user:

a first measurement is made by open circuiting each of said three spaced apart contact points and measuring an offset signal, Signal.sub.OFFSET, with said <u>stylus</u>;

a second measurement is made by applying the same signal to each of said three spaced apart contact points and measuring a full signal, Signal.sub.FULL, with said <u>stylus</u>;

a third measurement is made by applying a signal between a first two of said three spaced apart contact points with the other contact point left unconnected, the value of the signal applied between said first two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said first two contact points, Signal.sub.RAW-FIRST-TWO, with said

stylus;

a fourth measurement is made by applying a signal between a second two of said three spaced apart contact points with the other contact point left unconnected, the value of the signal applied between said second two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said second two contact points, Signal.sub.RAW-SECOND-TWO, with said stylus; and

calculating the relative position to which the stylus is pointed by the user relative to said first two contact points and said second two contact points using the following equations, the values from those equations being coordinates on an equipotential map of the user selected point to which the user is pointing said stylus with the axes of those coordinates being imaginary lines between each of said first two contact points and said second two contact points:

P.sub.FIRST-TWO =(Signal.sub.RAW-FIRST-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET);

and

P.sub.SECOND-TWO =(Signal.sub.RAW-SECOND-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET).

28. The electrographic sensor unit of claim 27 wherein:

a predetermined signal map of said layer of conductive material is prestored in said processor; and

said calculated values of P.sub.FIRST-TWO and P.sub.SECOND-TWO are used by said processor in conjunction with said signal map to translate said calculated values into a physical position on said surface to which said user is pointing said stylus.

29. The electrographic sensor unit of claim 1 wherein: said layer of conductive material is formed into a closed three dimensional shape; and

said electrographic sensor further includes a fourth contact point spaced apart from said three spaced apart contact points and electrically interconnected with said layer of conductive material.

30. The electrographic sensor unit of claim 29 wherein each plane defined by each combination of three of said four spaced apart contact points does not pass through a center point of said closed three dimensional shape.

31. The electrographic sensor unit of claim 29 wherein said position of said stylus is determined by said processor causing selected signals to be applied to various combinations of said four spaced apart contact points and a measured signal received by said stylus in response to each application of signals that are used by said processor to calculate the position to which said stylus is pointed by the user:

a first measurement is made by open circuiting each of said contact points and measuring an offset signal, Signal.sub.OFFSET, with said stylus;

a second measurement is made by applying the same signal to each of said four spaced apart contact points and measuring a full signal, Signal.sub.FULL, with said stylus;

a third measurement is made by applying a signal between a first two of said four spaced apart contact points with the other two contact points left unconnected, the value of the signal applied between said first two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said first two contact points, Signal.sub.RAW-FIRST-TWO, with said stylus;

a fourth measurement is made by applying a signal between a second two of said four spaced apart contact points with the other two contact points left unconnected, the value of the signal applied between said second two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said second two contact points, Signal.sub.RAW-SECOND-TWO, with said <u>stylus</u>;

a fifth measurement is made by applying a signal between a third two of said four spaced apart contact points with the other two contact points left unconnected, the value of the signal applied between said third two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between those said third two contact points, Signal.sub.RAW-THIRD-TWO, with said <u>stylus</u>; and

calculating the relative <u>position to which said stylus</u> is pointed by the user relative to said first two contact points, said second two contact points, and said third two contact points using the following equations, the values from those equations being coordinates on an equipotential <u>map</u> of the user selected point to which the user is pointing said <u>stylus</u> with the axes of those coordinates being imaginary lines between each of said first two contact points, said second two contact points, and said third two contact points:

$$P.sub.FIRST-TWO = (Signal.sub.RAW-FIRST-TWO - (Signal.sub.OFFSET)/(Signal.sub.FULL - Signal.sub.OFFSET); P.sub.SECOND-TWO = (Signal.sub.RAW-SECOND-TWO - (Signal.sub.OFFSET)/ (Signal.sub.FULL - Signal.sub.OFFSET); and P.sub.THIRD-TWO = (Signal.sub.RAW-THIRD-TWO - (Signal.sub.OFFSET)/ (Signal.sub.FULL - Signal.sub.OFFSET).$$

32. The electrographic <u>sensor</u> unit of claim 31 wherein:

a predetermined signal <u>map</u> of said conductive material is prestored in said <u>processor</u>; and

said calculated values of P.sub.FIRST-TWO, P.sub.SECOND-TWO, and P.sub.THIRD-TWO are used by said <u>processor</u> in conjunction with said signal <u>map</u> to translate said calculated values into a physical <u>position</u> on said surface to which said user is pointing said <u>stylus</u>.

33. The electrographic <u>sensor</u> unit of claim 1 wherein said <u>processor</u> includes:

a microprocessor having a data bus associated therewith;

a memory system interfacing with said data bus;

a signal generator stage coupled to said microprocessor to generate and apply various signals to various ones, and various combinations, of said three spaced apart contact points under control of said microprocessor; and

a signal measurement stage coupled to said microprocessor and said probe assembly to capture and condition signals <u>received</u> from said probe system under control of said microprocessor.

34. The electrographic <u>sensor</u> unit of claim 33 wherein said signal generator stage includes:

a signal generator; and

a switching system coupled between said signal generator and said three spaced apart contact points on said layer to selectively apply a signal from said signal generator to selected ones of said three spaced apart contact points under the direction of said microprocessor.

35. The electrographic <u>sensor</u> unit of claim 34 wherein:

said memory system includes prestored information relative to various coordinates on said layer; and

said processor further includes:

an electronic delivery system for providing information from said memory system to said user relative the user selected position of said stylus.

36. An electrographic sensor unit for use in determining the position of a user selected point on the surface thereof, which comprises:

an indicator panel having:

a bottom layer of a conductive material with an electrical resistivity;

a top layer of a flexible conductive material; and

an inner layer between said top and bottom layers wherein said inner layer is a non-conductive, compressible material;

three spaced apart contact points electrically interconnected with said conductive material of said bottom layer;

a processor connected to said three spaced apart contact points and disposed to selectively apply a signal to each of said three spaced apart contact points; and

an electrical conductor coupled between said processor and said top layer of said indicator panel to transmit signals received by said top layer from said bottom layer when said user depresses a point on said top layer toward said bottom layer in vicinity of a user selected point on said top layer with a finger;

wherein said position of said finger of said user relative to said bottom layer is determinable from two signals received from said top layer by said processor each in relation to a similar excitation of two different pairs of said three spaced apart contact points interconnected with said bottom layer.

37. The electrographic sensor unit as in claim 36 wherein:

said layer of conductive material has a defined edge and is formed into a two or three dimensional shape; and

said three spaced apart contact points are placed on said layer of conductive material such that all points of interest to a user that may be designated by pointing said finger thereat such that each point of interest is in the field of view of two different pair of said three spaced apart contact points with the included angle at each contact point of each pair of contact points is less than 90.degree., with the included angle being that angle defined by the vectors between said pair of contact points, and said contact point corresponding to said included angle and said point of interest to which said user is pointing.

38. The electrographic sensor unit as in claim 36 wherein:

each of said three spaced apart contact points includes a tandem pair of contacts with a first of said tandem pair of contacts connected to said processor to receive signals to be applied to said layer and a second of said tandem pair of contacts connected to said processor from which measurements of signals is to be made; and

said processor includes:

three feedback compensation circuits each associated with a different one of said three spaced apart contact points and each having an input and an output terminal, said input terminal coupled to said second of said tandem pair of contacts of the associated one of said three spaced apart contact points; and

three amplifiers each associated with a different one of said three spaced apart

contact points and each having one output terminal and two input terminals, said output terminal coupled to said first of said tandem pair of contacts of the associated one of said three spaced apart contact points, one of said input terminals connected to the output terminal of said feedback compensation circuit associated with the same one of said three spaced apart contact points, and said second input terminal connected to <u>receive</u> said signals that are selectively applied by said <u>processor</u> to the corresponding one of said three spaced apart contact points.

39. The electrographic <u>sensor</u> unit as in claim 36 wherein said <u>position</u> of said finger of said user is determined by said <u>processor</u> causing selected signals to be applied to various combinations of said three spaced apart contact points and a measured signal <u>received</u> by said top layer in response to each application of signals that are used by said <u>processor</u> to calculate the <u>position</u> to which said user is pointing,

a first measurement is made by open circuiting each of said three spaced apart contact points and measuring an offset signal, Signal.sub.OFFSET, with said top layer;

a second measurement is made by applying the same signal to each of said three spaced apart contact points and measuring a full signal, Signal.sub.FULL, with said top layer;

a third measurement is made by applying a signal between a first two of said three spaced apart contact points with the other contact point left unconnected, the value of the signal applied between said first two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said first two contact points, Signal.sub.RAW-FIRST-TWO, with said top layer;

a fourth measurement is made by applying a signal between a second two of said three spaced apart contact points with the other contact point left unconnected, the value of the signal applied between said second two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said second two contact points, Signal.sub.RAW-SECOND-TWO, with said top layer; and

calculating the relative <u>position</u> to which said finger of the user is pointing relative to said first two contact points and said second two contact points using the following equations, the values from those equations being coordinates on an equipotential <u>map</u> of the user selected point to which the user is pointing with the axes of those coordinates being imaginary lines between each of said first two contact points and said second two contact points:

P.sub.FIRST-TWO =(Signal.sub.RAW-FIRST-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET);

and

P.sub.SECOND-TWO =(Signal.sub.RAW-SECOND-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET);

a predetermined signal <u>map</u> of said layer of conductive material is prestored in said <u>processor</u>; and

said calculated values of P.sub.FIRST-TWO and P.sub.SECOND-TWO are used by said <u>processor</u> in conjunction with said signal <u>map</u> to translate said calculated values into a physical <u>position</u> on said surface to which said user is pointing.

40. The electrographic <u>sensor</u> unit as in claim 36 wherein said <u>processor</u> includes:

a microprocessor having a data bus associated therewith;

a memory system interfacing with said data bus;

a signal generator stage coupled to said microprocessor to generate and apply various signals to various ones, and various combinations, of said three spaced apart contact points under control of said microprocessor; and

a signal measurement stage coupled to said microprocessor and said electrical conductor to capture and condition signals received from said top layer under control of said microprocessor.

41. The electrographic sensor unit of claim 40 wherein said signal generator stage includes:

a signal generator; and

a switching system coupled between said signal generator and said three spaced apart contact points on said bottom layer to selectively apply a signal from said signal generator to selected ones of said three spaced apart contact points under the direction of said microprocessor.

42. The electrographic sensor unit of claim 41 wherein:

said memory system includes prestored information relative to various coordinates on said bottom layer; and

said processor further includes:

an electronic delivery system for providing information from said memory system to said user relative the position of said finger of the user.

43. An electrographic sensor unit in the form of a globe for use in determining the position of a user selected point on the surface thereof, which comprises:

a sphere formed of a layer of a conductive material having a substantially uniform electrical resistivity and an outer surface;

a set of four spaced apart contact points electrically interconnected with said layer of conductive material of said sphere;

a processor connected to said set of four spaced apart contact points and disposed to selectively apply a signal to each of said four spaced apart contact points; and

a probe assembly, including a stylus, coupled to said processor, said stylus disposed to be positioned by a user in vicinity of a user selected point on said surface of said sphere and to receive signals from said layer when said four spaced apart contact points have signals selectively applied thereto by said processor;

wherein said position of said stylus relative to said surface of said sphere is determinable from three signals received from said stylus by said processor each in relation to a similar excitation of three different pairs of said four spaced apart contact points on said sphere by said processor.

44. The electrographic sensor unit of claim 43 further including:

a non-conductive skin placed over said sphere with said skin displaying thereon geographical features of a selected star, planet or other heavenly body.

45. The electrographic sensor unit of claim 44 wherein said processor determines coordinates of the user selected position of said stylus in terms of standard coordinates of the geographical features displayed on said skin.

46. The electrographic sensor unit of claim 45 wherein said processor includes:

a memory in which information is prestored relative to geographic features of various coordinates on said skin; and

an electronic delivery system for providing information from said memory to said
user relative the user selected position of said stylus.

47. The electrographic sensor unit of claim 43 wherein:

said four spaced apart contact points are placed on said layer of conductive
material with all points of interest to a user that may be designated by pointing
said stylus thereat are in the field of view of two different pair of said four
spaced apart contact points with the included angle at each contact point of each
pair of contact points is less than 90.degree., with the included angle being that
angle defined by the vectors between said pair of contact points, and said contact
point corresponding to said included angle and said point of interest to which said
stylus is being pointed by said user;

said position of said stylus is determined by said processor causing selected
signals to be applied to various combinations of said four spaced apart contact
points and a measured signal received by said stylus in response to each application
of signals that are used by said processor to calculate the position to which said
stylus is pointed by the user;

a first measurement is made by open circuiting each of said four spaced apart
contact points and measuring an offset signal, Signal.sub.OFFSET, with said stylus;

a second measurement is made by applying the same signal to each of said four spaced
apart contact points and measuring a full signal, Signal.sub.FULL, with said stylus;

a third measurement is made by applying a signal between a first two of said four
spaced apart contact points with the other two contact points left unconnected, the
value of the signal applied between said first two contact points has a fixed
relationship to the value of the signal used to make said second measurement, and
measuring a raw signal between said first two contact points,
Signal.sub.RAW-FIRST-TWO, with said stylus;

a fourth measurement is made by applying a signal between a second two of said four
spaced apart contact points with the other two contact points left unconnected, the
value of the signal applied between said second two contact points has a fixed
relationship to the value of the signal used to make said second measurement, and
measuring a raw signal between said second two contact points,
Signal.sub.RAW-SECOND-TWO, with said stylus;

a fifth measurement is made by applying a signal between a third two of said four
spaced apart contact points with the other two contact points left unconnected, the
value of the signal applied between said third two contact points has a fixed
relationship to the value of the signal used to make said second measurement, and
measuring a raw signal between those said third two contact points,
Signal.sub.RAW-THIRD-TWO, with said stylus;

calculating the relative position to which said stylus is pointed by the user
relative to said first two contact points, said second two contact points, and said
third two contact points using the following equations, the values from those
equations being coordinates on an equipotential map of the user selected point to
which the user is pointing said stylus with the axes of those coordinates being
imaginary lines between each of said first two contact points, said second two
contact points, and said third two contact points:

_____   P.sub.FIRST-TWO = (Signal.sub.RAW-FIRST-TWO -
(Signal.sub.OFFSET)/(Signal. sub.FULL - Signal.sub.OFFSET); P.sub.SECOND-TWO =
(Signal.sub.RAW-SECOND-TWO - (Signal.sub.OFFSET)/ (Signal.sub.FULL -
Signal.sub.OFFSET); and P.sub.THIRD-TWO = (Signal.sub.RAW-THIRD-TWO -
(Signal.sub.OFFSET)/ (Signal.sub.FULL - Signal.sub.OFFSET).

_____

a predetermined signal map of said conductive material is prestored in said
processor; and

said calculated values of P.sub.FIRST-TWO, P.sub.SECOND-TWO, and P.sub.THIRD-TWO are used by said <u>processor</u> in conjunction with said signal <u>map</u> to translate said calculated values into a physical <u>position</u> on said surface to which said user is pointing said <u>stylus</u>.

48. The electrographic <u>sensor</u> unit as in claim 43 wherein said <u>processor</u> includes:

a microprocessor having a data bus associated therewith;

a memory system interfacing with said data bus;

a signal generator stage coupled to said microprocessor to generate and apply various signals to various ones, and various combinations, of said four spaced apart contact points under control of said microprocessor; and

a signal measurement stage coupled to said microprocessor and said probe assembly to capture and condition signals <u>received</u> from said probe assembly under control of said microprocessor.

49. The electrographic <u>sensor</u> unit of claim 48 wherein said signal generator stage includes:

a signal generator; and

a switching system coupled between said signal generator and said contact points on said layer to selectively apply a signal from said signal generator to selected ones of said four spaced apart contact points under the direction of said microprocessor.

50. The electrographic <u>sensor</u> unit of claim 49 wherein:

said memory system includes prestored information relative to various coordinates on said layer; and

said <u>processor</u> further includes:

an electronic delivery system to provide information from said memory system to said user relative the user selected <u>position of said stylus</u>.

51. An electrographic <u>sensor</u> unit for use in determining the <u>position</u> of a selected point, which comprises:

a first layer of a conductive material having an electrical resistivity and a first surface;

a first set of three spaced apart contact points electrically interconnected with said first layer of conductive material;

a second layer of a conductive material having an electrical resistivity and a second surface;

a second set of three spaced apart contact points electrically interconnected with said second layer of conductive material;

a <u>processor</u> connected to each of said first and second sets of three spaced apart contact points and disposed to selectively apply a signal to each of said three spaced apart contact points in each of said first and second sets thereof; and

a probe assembly, including a <u>stylus</u>, coupled to said <u>processor, said stylus</u> disposed to be positioned by a user in vicinity of a user selected point on said first or second surface of said first and second layers and to <u>receive</u> signals from said layer associated with said user selected point when said corresponding set of three spaced apart contact points have signals selectively applied thereto;

wherein <u>identification</u> of which of said first and second surfaces said <u>stylus</u> is adjacent to is accomplished by said <u>processor</u> by independently measuring two signals from each of said first and second layers <u>received by said stylus,</u> combining said signals from the same layer independent of the signals <u>received</u> from the other layer to form a first and a second comparative value with each said comparative value associated with a different one of said first and second layers, and independently comparing each of said first and second comparative values to a preselected threshold value with the layer associated with the one of said first and second comparative values that is greatest and is greater than said threshold value being the layer said <u>stylus</u> is closest to and therefore an <u>identified</u> layer of said first and second layers; and

wherein said <u>position of said stylus</u> relative to said <u>identified</u> one of said first or second layers is determinable by said <u>processor</u> from signals <u>received from said stylus</u> each in relation to a similar excitation of all of said three contact points on the <u>identified</u> one of said first and second layers and two different pairs of said three spaced apart contact points on the <u>identified</u> one of said first and second layers under control of said <u>processor</u>.

52. The electrographic <u>sensor</u> unit of claim 51 wherein:

said first and second layers are in the shape of a first and second hemisphere; and

said electrographic <u>sensor</u> unit further includes and electrically insulative spacer between said first and second hemispheres to maintain them in the shape of a sphere while not making electrical contact with each other.

53. The electrographic <u>sensor</u> unit of claim 52 further including:

a non-conductive skin placed over said first and second hemispheres with said skin displaying thereon <u>geographical features</u> of a selected star, planet or other heavenly body.

54. The electrographic <u>sensor</u> unit of claim 53 wherein said <u>processor</u> determines coordinates of the user selected <u>position of said stylus</u> in terms of standard coordinates of the <u>geographical features</u> displayed on said skin.

55. The electrographic <u>sensor</u> unit of claim 54 wherein said <u>processor</u> includes:

a memory in which information is prestored relative to <u>geographic features</u> of various coordinates on said skin; and

an electronic delivery system to provide information from said memory to said user relative the user selected <u>position of said stylus</u>.

56. The electrographic <u>sensor</u> unit of claim 51 wherein:

each of said first and second sets of said three spaced apart contact points are placed on the corresponding one of said first and second layer of conductive material such that all points of interest to a user that may be designated by pointing said <u>stylus</u> thereat are in the field of view of two different pair of the corresponding three spaced apart contact points on the one of said first and second layers to which the user is pointing with the included angle at each contact point of each pair of contact points is less than 90.degree., with the included angle being that angle defined by the vectors between said pair of contact points, and said contact point corresponding to said included angle and said point of interest to which said <u>stylus</u> is being pointed by said user;

said <u>position of said stylus</u> is determined by said <u>processor</u> causing selected signals to be applied to various combinations of said first and second sets of said three spaced apart contact points and a measured signal <u>received by said stylus</u> in response to each application of signals that are used by said <u>processor</u> to calculate the <u>position to which said stylus</u> is pointed by the user,

a first measurement is made by open circuiting each of said contact points and

measuring an offset signal, Signal.sub.OFFSET, with said <u>stylus</u>;

a second measurement is made by applying the same signal to each of said contact points and measuring a full signal, Signal.sub.FULL, with said <u>stylus</u>;

a third measurement is made by applying a signal between a first two of said three contact points with the other contact point left unconnected, the value of the signal applied between said first two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said first two contact points, Signal.sub.RAW-FIRST-TWO, with said <u>stylus</u>;

a fourth measurement is made by applying a signal between a second two of said three contact points with the other contact point left unconnected, the value of the signal applied between said second two contact points has a fixed relationship to the value of the signal used to make said second measurement, and measuring a raw signal between said second two contact points, Signal.sub.RAW-SECOND-TWO, with said <u>stylus</u>; and

calculating the relative <u>position to which the stylus</u> is pointed by the user relative to said first two contact points and said second two contact points using the following equations, the values from those equations being coordinates on an equipotential <u>map</u> of the user selected point to which the user is pointing said <u>stylus</u> with the axes of those coordinates being imaginary lines between each of said first two contact points and said second two contact points:

P.sub.FIRST-TWO =(Signal.sub.RAW-FIRST-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET);

and

P.sub.SECOND-TWO =(Signal.sub.RAW-SECOND-TWO -Signal.sub.OFFSET)/(Signal.sub.FULL -Signal.sub.OFFSET);

a predetermined signal <u>map</u> of said layer of conductive material is prestored in said <u>processor</u>; and

said calculated values of P.sub.FIRST-TWO and P.sub.SECOND-TWO are used by said <u>processor</u> in conjunction with said signal <u>map</u> to translate said calculated values into a physical <u>position</u> on said surface to which said user is pointing said <u>stylus</u>.

57. The electrographic <u>sensor</u> unit as in claim 51 wherein said <u>processor</u> includes:

a microprocessor having a data bus associated therewith;

a memory system interfacing with said data bus;

a signal generator stage coupled to said microprocessor to generate and apply various signals to various ones, and various combinations, of said first set of three spaced apart contact points under control of said microprocessor; and

a signal measurement stage coupled to said microprocessor and said probe assembly to capture and condition signals <u>received</u> from said probe assembly under control of said microprocessor.

58. The electrographic <u>sensor</u> unit of claim 57 wherein said signal generator stage includes:

a signal generator; and

a switching system coupled between said signal generator and said contact points on said layer to selectively apply a signal from said signal generator to selected ones of said contact points under the direction of said microprocessor.

59. The electrographic <u>sensor</u> unit of claim 58 wherein:

said memory system includes prestored information relative to various coordinates on each of said first and second layers; and

said processor further includes:

an electronic delivery system to provide information from said memory system to said user relative the user selected position of said stylus. .

60. A method for location of a user selected position on an electrographic sensor unit having a layer of a conductive material with an electrical resistivity and K spaced apart contact points electrically interconnected with said layer of conductive material where N of said K spaced apart contact points are used to locate said user selected position and where N has an integer value of three to K, a processor disposed to selectively apply a signal to each of said N contact points and to determine position coordinates of said user selected position, and a means for detecting and delivering a signal from the user selected position of said electrographic sensor unit to said processor, said method including the steps of:

a. applying a first selected signal to all of said K spaced apart contact points;

b. measuring a first measured signal at said user selected position with said first measured signal corresponding to the signal application of step a.;

c. sequentially applying a selected second signal between J different pairs of said N of said K spaced apart contact points with said second signal having a selected relationship to said first signal, where J is an integer value between 2 and (N-1);

d. sequentially measuring J second measured signals at said user selected position with each one of said J measured signals corresponding to a different one of said J second signal applications of step c.; and

e. calculating a value proportional to a position coordinate between each pair of said J pairs of contact points of step c. that is proportional to a ratio of each one of said J second measured signals of step d. and said first measured signal of step b. to define said user selected position with J coordinates relative to said contact points used in said J second signal measurements.

61. The method for location of a user selected position on an electrographic sensor unit as in claim 60 wherein:

said method further includes the steps of:

f. measuring a third measured signal at said user selected position with all of said N of said K space apart contact points open circuited prior to step e.; and

step e. further includes the steps of:

g. subtracting said third measured signal individually from each of said J second measured signals to form J difference values; and

h. calculating a value proportional to a position coordinate between each pair of said J pairs of contact points of step c. that is proportional to a ratio of each one of said J difference values of step g. and said first measured signal of step b. to define said user selected position with J coordinates relative to said N of said K space apart contact points used to measure said J second measured signals.

62. The method for location of a user selected position on an electrographic sensor unit as in claim 61 wherein:

a predetermined signal map of said layer of conductive material is prestored in said processor; and

said method further includes the step of:

i. translating said J difference values proportional to a <u>position</u> coordinate system of step h. using said prestored signal <u>map</u> into a physical <u>position</u> on said layer which said user has selected.

63. The method for <u>location</u> of a user selected <u>position</u> on an electrographic <u>sensor</u> unit as in claim 62 wherein:

said electrographic <u>sensor</u> unit further includes a nonconductive skin placed over said layer with said skin displaying thereon graphical <u>features</u>; and

said method further includes the step of:

j. translating said physical <u>position</u> of step i. into a set of coordinates related to said graphical <u>features</u> displayed on said skin.

64. The method for <u>location</u> of a user selected <u>position</u> on an electrographic <u>sensor</u> unit as in claim 63 wherein:

said <u>processor</u> further includes:

a memory in which information is prestored relative to said graphical <u>features</u> for various coordinates on said skin; and

an electronic delivery system to provide information from said memory to said user relative the user selected position: and

said method further includes the step of:

k. using said coordinates of step j. as a pointer to said memory to recall information relative to said graphical <u>features</u> on said skin at said coordinates; and

l. applying said recalled information of step k. to said electronic delivery system for presentation to said user.

65. The method for <u>location</u> of a user selected <u>position</u> on an electrographic <u>sensor</u> unit as in claim 60 wherein said method, prior to step a., further includes the step of:

m. selecting locations on said layer for said N contact points such that all potential <u>positions</u> that maybe be selected by said user are in a field of view of J different pair of said N contact points.

66. The method for <u>location</u> of a user selected <u>position</u> on an electrographic <u>sensor</u> unit as in claim 65 wherein a potential <u>position</u> that may be selected by a user is in the field of view of a pair of contact points when an included angle at each contact point of said pair of contact points is less than 90.degree., with the included angle being that angle defined by the vectors between said pair of contact points, and said contact point corresponding to said included angle and said potential <u>position</u> that may be selected by a user.

67. The method for <u>location</u> of a user selected <u>position</u> on an electrographic <u>sensor</u> unit as in claim 60 wherein:

each of said N contact points includes a tandem pair of contacts with a first contact for <u>receiving</u> signals, and a second contact at which signals are measured;

said electrographic <u>sensor</u> unit further includes:

N two input terminal, one output terminal amplifiers with one of said input terminals coupled to said <u>processor</u> and said output terminal connected to the first contact of a corresponding one of said N contact points; and

N feedback compensation circuits each having an input terminal and an output terminal, each of said N feedback compensation circuits associated with a

corresponding one of said N contact points with to said input terminal connected to said second contact of said contact point of said corresponding one of said N contact points and said output terminal connected to said other input terminal of said corresponding amplifier;

in step a. said first selected signal is applied to said first contact of each of said N contact points by the corresponding ones of said N amplifiers;

in step c. each of said sequentially applied selected second signal is applied between said first contact of each of said (N-1) different pairs of said N contact points from the output terminal of said corresponding one of said N amplifiers; and

said method further includes the step of:

n. individually compensating for contact resistance of each of said N contact points by adjusting an output signal level of each of said N amplifiers in response to an output signal from the corresponding one of said N feedback compensation circuits.

68. The method for <u>location</u> of a user selected <u>position</u> on an electrographic <u>sensor</u> unit as in claim 60 wherein:

said <u>processor</u> includes an (N+1) <u>position</u> switch connected to <u>receive</u> signals to be measured by said <u>processor</u> individually from said means for detecting and delivering a signal from said user selected <u>position</u> of said electrographic <u>sensor</u> unit and each of said N contact points;

said method further includes the steps of:

o. injecting a known third signal between each pair of said N contact points;

p. measuring a resultant third measured signal at a contact point other than either contact point of each of said pair of said N contact points; and

q. solving N simultaneous equations for the resistance values of each of said N contact points, wherein each of said simultaneous equations is generalized as follows for each of said N contact points where for purposes of that equation said known third signal of step o. is injected between contact points A and B and the measured third signal of step p. is measured at contact point C:

Signal.sub.C =Signal.sub.IN [(X.multidot.R.sub.AB +R.sub.B)/(R.sub.AB +R.sub.B +R.sub.A)];

where:

Signal.sub.IN is the signal injected by said <u>processor</u> between each pair of contact points;

R.sub.AB is the bulk resistance value of the layer of conductive material between contact points A and B;

X is the fraction of the bulk resistance value between the contact points A and B; and

R.sub.A and R.sub.B are the contact resistance values at contact points A and B.

69. The method for <u>location</u> of a user selected <u>position</u> on an electrographic <u>sensor</u> unit as in claim 60 wherein said first and second selected signals are AC signals of a selected frequency that can be detected by said means for detecting and delivering.

70. The method for <u>location</u> of a user selected <u>position</u> on an electrographic <u>sensor</u> unit as in claim 60 wherein:

said first and second selected signals are DC signals; and

said means for detecting and delivering makes electrical contact with said layer to detect said second measured signal.

71. A method for location of a user selected position on an electrographic sensor unit having M layers of a conductive material each electrically isolated from each other and each having an electrical resistivity and K spaced apart contact points electrically interconnected with the corresponding layer of conductive material where N of said K spaced apart contact points are used to locate said user selected position and where N has an integer value of three to K, a processor disposed to selectively apply a signal to each of said N contact points of each of said M layers and to determine which of said M layers and position coordinates of said user selected position on the corresponding one of said M layers, and a means for detecting and delivering a signal from the user selected position on said electrographic sensor unit to said processor, with the user having selected said position said method including the steps of:

a. sequentially applying a first selected signal to all of said K spaced apart contact points on each of said M layers in turn;

b. measuring a first measured signal at said user selected position for each of said M layers with said first measured signal corresponding to the signal application of step a. for each of said M layers;

c. measuring a second measured signal at said user selected position on the user selected layer with each of said K spaced apart contact points on each of said M layers open circuited;

d. subtracting said second measured signal from step c. from said first measured signal for each of said M layers from step b. to form M difference values;

e. comparing each of said M difference values from step d. against a preselected threshold value; and

f. identifying the one of said M layers on which said user selected position is located as the layer associated with the difference value that is both greater than said threshold value and that exceeds said threshold value by the greatest amount.

72. The method for location of a user selected position on an electrographic sensor unit as in claim 71 further including the steps of:

g. sequentially applying a selected third signal between J different pairs of said N contact points of the layer identified in step f. with said third signal having a selected relationship to said first signal, were J has an integer value of 2 to (N-1);

h. sequentially measuring J third measured signals at said user selected position with each one of said J measured signals corresponding to a different one of the applications of said selected third signal of said J different pairs of said N contact points of step g.; and

i. calculating a value proportional to a position coordinate between each pair of said J pairs of N contact points of step g. that is proportional to a ratio of each one of said J third measured signals of step h. and said first measured signal of step b. to define said user selected position with J coordinates relative to said N contact points used in said J second signal measurements on said identified one of said M layers.

73. An electrographic sensor unit for use in determining the position of a selected point, which comprises:

a layer of a conductive material having an electrical resistivity and a surface;

K spaced apart contact points electrically interconnected with said layer of conductive material;

a <u>processor</u> connected to said K spaced apart contact points and disposed to selectively apply a signal to N of said K spaced apart contact points where N has an integer value of 3 to K; and

a probe assembly, including a <u>stylus,</u> coupled to said <u>processor, said stylus</u> disposed to be positioned by a user in vicinity of a user selected point on said surface of said layer and to <u>receive</u> signals from said layer when N of said K spaced apart said contact points have signals selectively applied thereto;

wherein said <u>position of said stylus</u> relative to said surface of said layer is determinable by said <u>processor</u> from signals <u>received from said stylus</u> each in relation to a similar excitation of J different pairs of said K spaced apart contact points under control of said <u>processor,</u> where J is an integer value of 2 to (N-1).